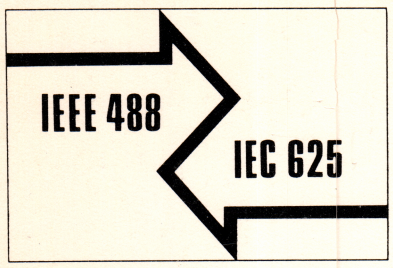

IEEE-488/IEC-625 BUS Interface for Digital Storage Oscilloscope PM3350 or PM3352

PM8957

Instruction Manual

4822 872 03322
871114/1

I&E

Industrial & Electro-acoustic Systems Division

**Industrial &
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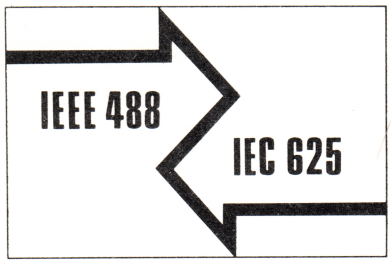

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NOTE: The design of this interface is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.

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1. INTRODUCTION

This interface is a general purpose bus interface according to the IEEE-488/IEC-625 document by which the oscilloscope is adapted to make communication possible with other IEEE-/IEC-bus compatible measuring instruments. This under the control of an IEEE-/IEC-bus controller.

For more detailed information about the bus system refer to the PHILIPS INSTRUMENTATION SYSTEMS "REFERENCE MANUAL" 9499 997 00411.

2. INSTALLATION INSTRUCTIONS

2.1 INITIAL INSPECTION

Check the contents of the shipment for completeness and note whether any damge has occured during transport. If the contents are incomplete, or there is damage, a claim should be filed with the carrier immediately, and the Philips Sales or Service organisation should be notified in order to facilitate the repair or replacement of the instrument.

The following parts should be included in the shipment:

- 1 plug-in printed circuit board
- 1 flatcable with connectors and screws
- 1 instruction manual

2.2 REMOVING THE INSTRUMENT COVERS

WARNING: The removal of covers is likely to expose live parts, and also accessible terminals may be live. The instrument shall be disconnected from all voltage sources before any installation during which the instrument will be opened.
If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a qualified person who is aware of the hazards involved. Bear in mind that capacitors inside the instrument may still be charged even if the instrument has been separated from all voltage sources.

- Switch the power ON/OFF pushbutton switch to OFF.
- Disconnect the oscilloscope from the mains supply.

The instrument is protected by two covers: a top cover and a bottom cover.
To remove these covers, proceed as follows:

- Slacken the two screws that secure both covers, located at the rear of the instrument.
- Gently push each cover backwards until it can be lifted.
- The covers can be removed by lifting them clear of the instrument.

2.3 INSTALLING THE P.C.B. AND THE CABLES

For installation of the printed circuit board and the cables, see also figure 2.1.

Proceed as follows:

- Unscrew the screw that fix the mains cord to the rear of the chassis.
- Break out the cut-out for the IEEE socket at the rear of the instrument.
- Take the P^2CCD unit and the time base unit out of the instrument.
- Unlock the two mains wires on the metal plate and take out the metal rear plate.
- Install the IEEE connector with flat cable by shifting the flatcable through the hole reserved for this connector.
- Fix the IEEE connector with the two screws to the metal rear plate.
- Reinstall the metal rear plate and fix the two earth wires again.

NOTE: Take care to position the flat cable to the correct place. Do not damage this cable when mounting the P^2CCD unit and the time base unit again.

- Reinstall the P^2CCD unit and the time base unit.

- Remove the digital unit and take-off the metal cover.
- Insert the IEEE p.c.b. in slot A11.
- Fix the metal cover and the flat cable connectors.

NOTE: Take care to connect flat cable A101, that was connected to X97, to the new connector X96 (see also figure 2.1).

- Reinstall the digital unit again.

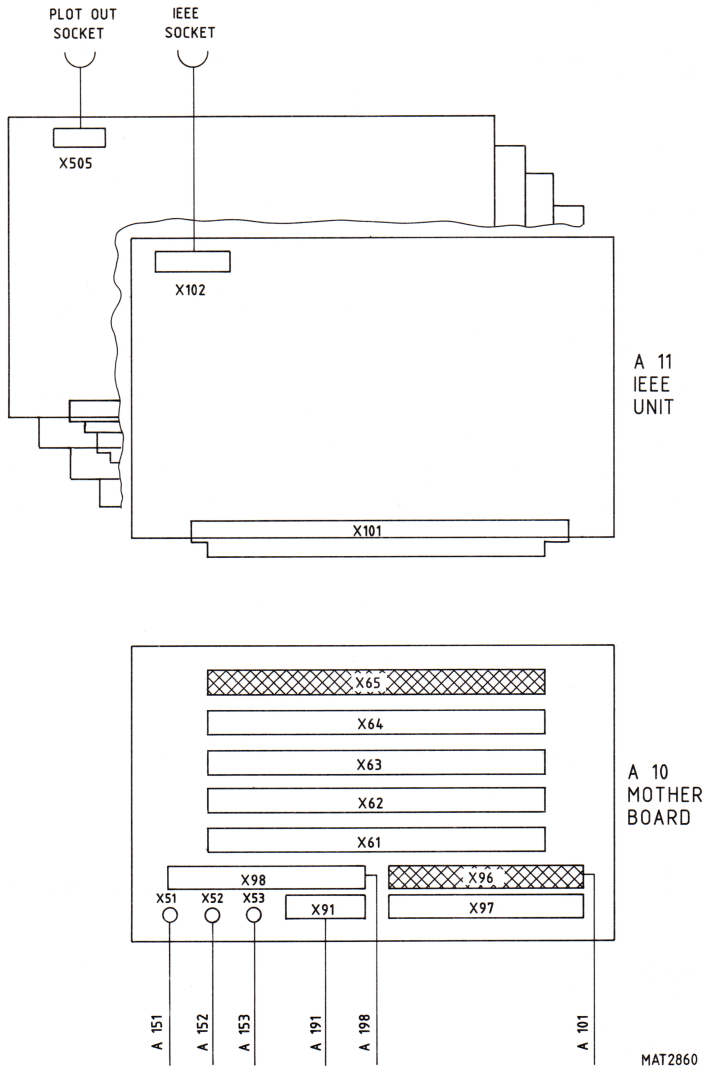


Figure 2.1 Installing the IEEE unit

2.4 INSTALLING THE INSTRUMENTS COVERS

- Reinstall the covers by executing the steps mentioned in section 2.2 in the reversed sequence.
- Connect the peripheral equipment (e.g. a controller) to the IEEE-488 connector on the rear panel.
- Reconnect the oscilloscope to the mains supply.
- Switch the instrument on.

2.5 SETTINGS OF THE INTERFACE

Various settings, such as address for IEEE-488 should be done via the service menu. Therefore, refer to section 3.2 of this manual.

3. OPERATING INSTRUCTIONS

This chapter outlines the procedures and precautions necessary for operating the additional features, provided by this option.
It identifies and briefly describes the practical aspects of operation to the operator.

3.1 SWITCHING ON

After the oscilloscope has been connected to the mains (line) voltage in accordance with section 3 of the operating manual PM3350 it can be switched on with the power ON/OFF switch on the front panel.

If no back-up batteries are installed and the oscilloscope is switched on, the instrument is set in the SOFTSTART condition.
With back-up batteries installed, the oscilloscope settings at the moment of switching-off are restored and the oscilloscope starts up with the same settings.

3.2 SETTING THE INTERFACE

After switching-on the instrument is set to the device address 8 and to talker/listener mode, provided that the instrument has no back-up batteries installed.

However this can be changed in the application preselect menu "IEEE" of the oscilloscope.
To do so, proceed as follows:

- Press MENU and keep it pressed.
- Press also AUTO SET.
- Now the Service menu has been entered, the LCD should indicate "*".
- Press APPL, which is one of the CRT softkeys; the CRT should indicate "APPLICATION PRESELECT MENU " on the upper left side of the screen.
- Press IEEE; the CRT should indicate the IEEE addressing and the IEEE mode.

Now the IEEE address can be set between 0 ... 30 by means of the UP-DOWN address softkeys and the IEEE interface can be set to the following modes:

- talk only
- listen only
- talker/listener

The same can also be programmed as follows:

- SPL INTERFACE,ADDRESS XX	address setting
- SPL INTERFACE,TL_MODE TO	talk only
- SPL INTERFACE,TL_MODE LO	listen only
- SPL INTERFACE,TL_MODE TL	talker/listener

3.3 DIGITAL PLOT AND PRINTER MODES

The oscilloscope functions are now extended with DIGITAL PLOT and PRINTER modes. Both modes are split-up into screen plot (printer) and auto screen plot (printer) mode.

After switching-on the instrument is set to the analogue plot condition, provided that the instrument has no back-up batteries installed. Then the data for analogue plot is present on the ANALOGUE PLOT OUT socket.

However this can be changed in the application preselect menu "PLOT" of the oscilloscope. To do so, proceed as follows:

- Press MENU and keep it pressed.
- Press also AUTO SET.
- Now the Service menu has been entered, the LCD should indicate "APPLICATION PRESELECT MENU" on the upper left side of the screen.
- Press PLOT; the CRT should indicate the plot key function. This function can be changed between PLOT ANALOGUE, PLOT-DIGITAL and PRINTER by means of the CRT function softkey "PLOT-KEY".

Note that the information for the PLOT-DIGITAL and PRINTER are present on the IEEE-488 bus output socket at the rear of the oscilloscope.

NOTE: 1. To assure a good plotter-oscilloscope initialisation, first switch-on the plotter and then the oscilloscope in sequence. Also use this way of initialisation when you change the plotter language (HPGL-Philips and visa versa).

2. When for some reason the interface initialisation went wrong and the interface is blocked, a message
**********DIGITAL PLOT (PRINT) ERROR**********
is displayed on the screen of the oscilloscope. In this case:
   - Re-initialise the oscilloscope (switch off/on).
   - Check the cable connections to your plotter or printer.
   - Check the interface parameter settings.
   - Check the plotter (printer) interface selection.

3.3.1 Digital plot specification

Pressing the PLOT softkey activates the digital plotter and the PLOT segments on the LCD will light-up. During the plot action the text DIGITAL PLOTTER ACTIVE is visible on the bottom side of the screen. Pressing the PLOT softkey another time stops the plot action. The LCD shows also the progress of the plot action by means of a lighted segment of the DISPLAY PART.

Plotters:

After switching-on the PM8155 is selected as plotter type. However, different plotter types can be selected in the PLOT-D menu.
These types are:

- PM8153/1
- PM8153/6
- PM8154
- PM8155
- HP7475A
- HP7550

Plotter pens:

- Pen 1 is used for the data of channel A.
- Pen 2 is used for the data of channel B.
- Pen 3 is used for the data of register A.
- Pen 4 is used for the data of register B.
- Pen 5 is used for the text and the graticule.

Text:

Both text lines as displayed before the text DIGITAL PLOT ACTIVE is visible, are always plotted. For this pen 5 of the plotter is used.

Plot format:

The data plot area is 8 div. (H) x 10 div. (W).

NOTE: Full size plotting is not possible for the PM8154 plotter.

The plot format (including text) can be changed via menu PLOT-D with a multiplication factor. With a factor of 1.0, each division is 1 cm (H) x 1 cm (W). This factor has a range of 0.5 ... 2.0 with a resolution of 0.1

When AUTO OFF (screen plot mode) has been selected in the PLOT-D menu, the oscilloscope will return to its previous condition after completing the plot action.
But when AUTO ON (auto screen plot mode) has been selected, the instrument will perform a new single shot each time that a previous plot action has been completed. This means also that the instrument will then start a new plot action.

3.3.2 Printer specification

ATTENTION: This specification is only valid for EPSON FX80 printers or compatibles.

Pressing the plot softkey activates the printer and the plot segments in the LCD will light-up. During the print action the text "PRINTER ACTIVE" is visible on the bottom side of the screen. Pressing the plot softkey another time stops the print action. The LCD displays also the progress of the print action by means of a lighted segment of the DISPLAY PART.

Text:

Both text lines as displayed before the text "PRINTER ACTIVE" is visible, are always printed.

Print format:

The data print area is 8 div. (H) x 10 div. (W) and each division is 1 cm.

When AUTO OFF (screen print mode) has been selected in the PRINT menu, the oscilloscope will return to its previous condition after completing the print action.
But when AUTO ON (auto screen print mode) has been selected, the instrument will perform a single shot each time that a previous print action has been completed. This means also that the instrument will then start a new print action.

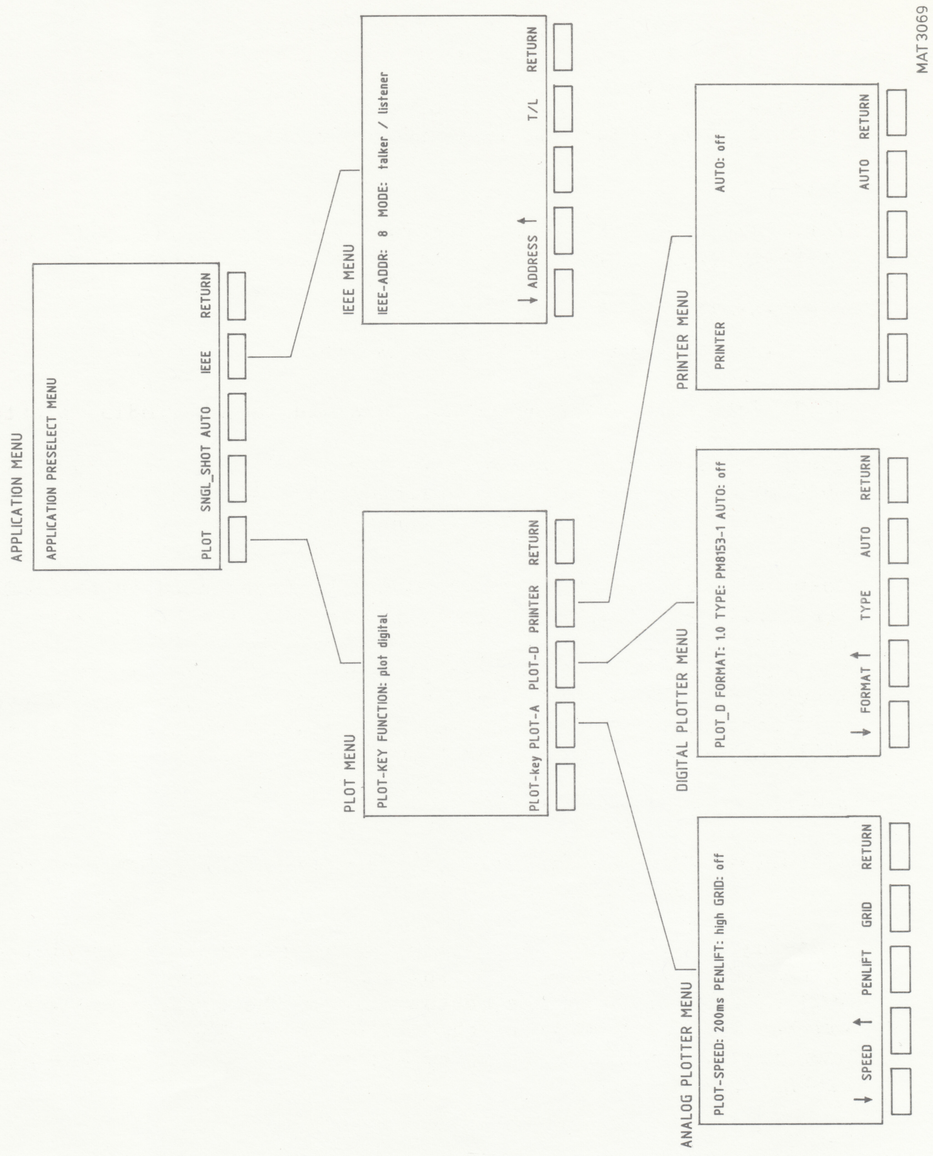


Figure 3.1 Application menu structure

4. CHARACTERISTICS

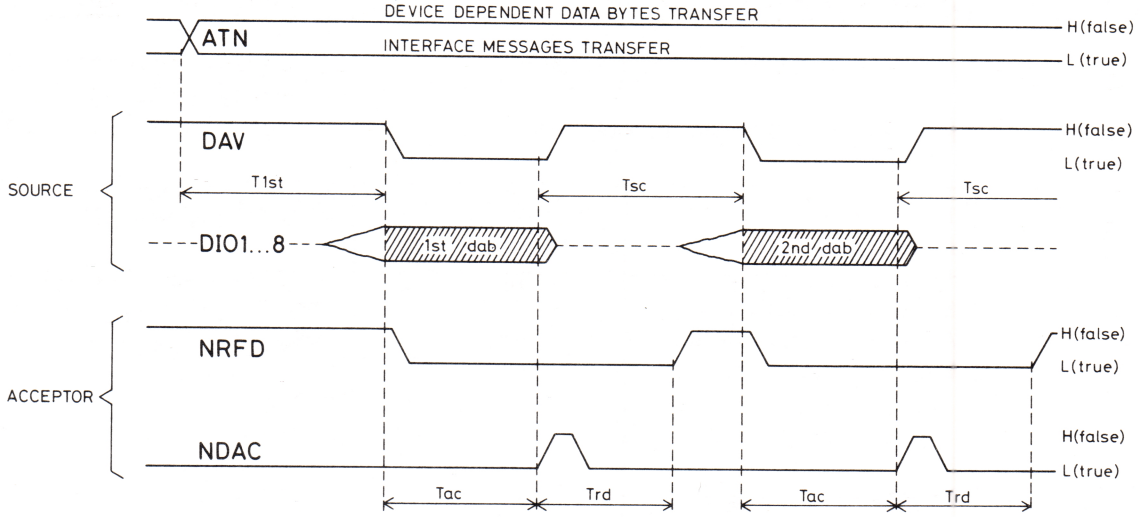
4.1 INTERFACE FUNCTION REPERTOIRE

Interface function	Identification code	Description
Source handshake	SH1	Complete capability
Acceptor handshake	AH1	Complete capability
Talker function	T5	- Basic talker - Serial poll - Talk only - Unaddress if MLA
Listener function	L3	- Basic listener - Listen only - Unaddress if MTA
Service request	SR1	Complete capability
Remote local	RL2	No local lock out
Parallel Poll	PPØ	No capability
Device clear	DC1	Complete capability
Device trigger	DT1	Complete capability
Controller	CØ	No capability

4.2 ELECTRICAL SPECIFICATIONS

Characteristics	Specification	Additional information
* Bus drivers	E2	Three state (true 0...0,8 V and false 0...5 V).
* Address	0 ... 30	Adjustable by software.
Default address	8	At delivery or after switching-off without battery back-up.
* Timing		See figure 4.1
Source handshake:		
First source time (Tlst)	< 250 ms ≤ 250 ms	Binary Decimal
Source time (Tsc)	≥ 11 us ≥ 29 us	Binary Decimal
Acceptor handshake:		
Accept time (Tac)	< 1 us ≤ 1 us	Binary Decimal
Ready time (Trd)	11 us 62 us	Binary Decimal

Tlst = Time needed for the first byte to get available on the bus.
Tsc = time needed for the next byte to get available on the bus.
Tac = Time needed to accept the information byte.
Trd = time needed until acceptor can receive a new information byte.



NOTES: -This timing diagram is valid for single source and single acceptor.
See also chapter 3.2.6. of the instrumentation systems manual 9499 997 00411.
-Trd starts at the moment that the acceptor sets NDAC false.

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Figure 4.1 Handshake timing

Characteristics	Specification	Additional information
* Front panel control		
Modes:	Local	Front panel exclusively under manual control. Remote LCD: off
	Remote locked	Front panel exclusively under IEEE 488. Remote LCD: on
Pushbuttons:	Command and question	Except ON/OFF switch.
Cont. controls:	Command	Except CRT controls, variables and x-position.
- Y-position	Centre: 0 Resolution: 16348	
- Level	Centre: 0 Resolution: 16348	
Probe identity:	Question only	
* Text-on crt control	Command and question	
Modes:	Text only Text combined with: Signal trace Settings read-out Cursors or channel identification	
Number of pages:	1	
Number of lines per page:	2	
Numbers of char. per page:	40	Including blanks

Characteristics	Specification	Additional information
* Cursor control	Command	Cursor read-out automatacally updated when cursors are set by IEEE 488 bus.
	Question	Cursor position can be sent to controller.
Resolving power:	1 : 4096	Absolute setting on screen (4000 equals 10 divisions horizontal).
Fully to the right of graticule at	4000	
Fully to the left of graticule at	0	Full memory 4095
Centre of graticule	2000	Mid-memory 2048

4.3 CODE SPECIFICATIONS

Used code : ISO - 7 bit code (ISO 646)
8 DIO lines : Logic levels: TTL
false (0 V < U < 0,8 V)
true (2 V < U < 5 V)

4.4 SEPARATORS

Separators : The unit separator (USP) can be any number between 0...255, except 27.

4.5 MECHANICAL CONNECTOR SPECIFICATION

- Type of output connector : IEEE 488 connector with female screwlocks DIN M3.5x0.6.
24 female contacts.

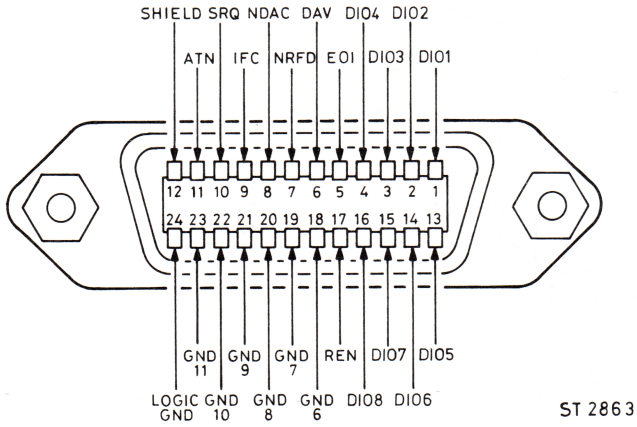

Figure 4.2 IEEE 488 bus connector

5. PROGRAMMING AN OSCILLOSCOPE

5.1 ADDRESS SETTING

First the correct oscilloscope (device) address has to be set. This can be done by means of the Service menu (see section 3.2) or programming SPL INTERFACE,ADDRESS XX.
Addresses may be set between 0 and 30 inclusive.

5.2 DESCRIPTION OF POSSIBLE ACTIONS

The interface is capable to carry out the following actions:

SYSTEM FUNCTIONS:

- Call for "identity" (IDT).

SYSTEM INTERFACE FUNCTIONS:

- Program a "unit separator" (USP).
- Program a "block separator" (BSP).
- Program a "record separator" (SPR).
- Program a wait time (delay time after every byte) (WTD).

SUPER FUNCTIONS:

Front handling (FRO Ø).

- Transfer of frontpanel settings from oscilloscope to controller.
- Transfer of frontpanel settings from controller to oscilloscope.

Register handling (REG Ø or REG 1)

- Transfer of register contents from oscilloscope to controller.
- Transfer of register contents from controller to oscilloscope.

SERVICE REQUEST:

- The oscilloscope can ask for service and will respond with its status word when the controller executes a serial poll.

MULTI-LINE MESSAGES:

- Do a GROUP EXECUTE TRIGGER
- Do a GO TO LOCAL
- Do a SELECTIVE DEVICE CLEAR
- Do a DEVICE CLEAR
- Do a SERIAL POLL

In all examples the oscilloscope is assumed to be set to device address 8.

5.3 TEST INTERFACE DEVICE COMMAND

The interface test is executed by means of the command TSI. The belonging ASCII-character is "U". This character is represented as 85 in decimal code, 55 in hex. code and Ø1ØØØ1 in binary. This binary bitpattern is sent from the controller via the bus to the IEEE bus interface in the oscilloscope.
The IEEE interface inverts this bitpattern into 1Ø1Ø1Ø1Ø.
Belonging Decimal code is 170 and hex. code is AA. The inverted bitpattern is returned via the bus to the controller. Depending on the type of controller that you use, a certain character will be displayed on the screen. Some controllers may print 170 on their screen. However for the following controllers the result is as follows;

HP85	If test OK: * on screen
Philips P2000C	If test OK: ⌊ on screen
Philips P3100	If test OK: ⌉ on screen

With the above test, the greatest part of the interface can be tested for correct functioning.

5.4 MESSAGE PROTOCOL FOR OSCILLOSCOPES

5.4.1 Introduction

This section deals with the user friendly messages sent to an oscilloscope or to receive from an oscilloscope via a controller. The basic purpose of the message structure is to provide a flexible tool for moving instructions and/or data into and out of the oscilloscope.

A message record consists of a sequence of one or more message blocks; each message block consists of one or more message units. They are terminated with the record-, block- and unit-separator respectively.

A MESSAGE RECORD IS A SEQUENCE OF SO CALLED MESSAGE UNITS.

- A message unit is the smallest possible sequence of characters (or bytes) constituting a related data set, generated, processed or interpreted as a unit.
- A message block is a sequence of one or more related message units. In practice, the number of characters within a block is restricted.
- A unit consists of two parts. A header and a body.
- Header and body are always separated by a space (SRØ).
- Units can be concatinated in a message.
- Units are always separated with a so called unit separator (SR1).
- Messages can be separated (using a block separator SR2 or a record separator SR3).

< HEADER >	< BODY >	< HEADER >	< BODY >	< HEADER >	< BODY >
SP	USP	SP	USP	SP	SPR
SRØ	SR1	SRØ	SR1	SRØ	SR3
First message unit		Second message unit		Third message unit	

MESSAGE RECORD

Message structure

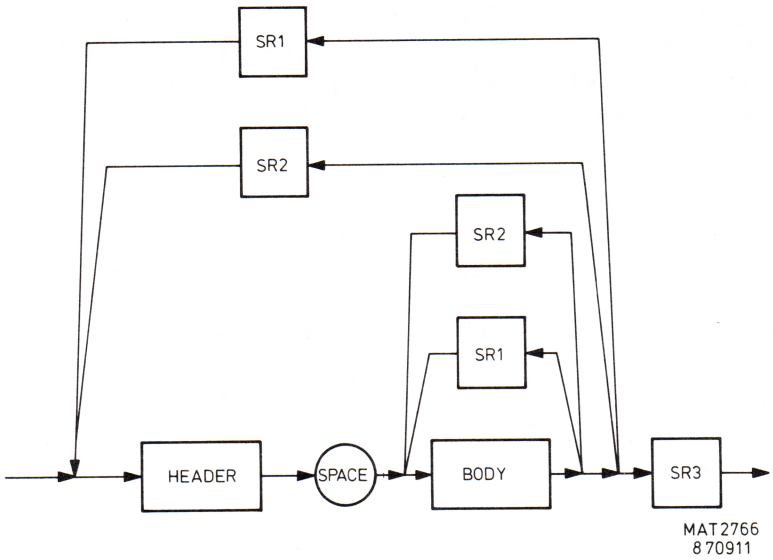

Figure 5.1 Message structure

A message record is a sequence of one or more message blocks constituting the complete device-message. A message begins when a device starts sending data for the first time following a reset or a previously sent record separator; it ends with the record separator.

5.4.2 Separators

Separators are used to distinguish between the various parts in the message, and to mark the several hierarchical levels. In desceeding order of level they are denoted as SR3, SR2 and SR1, for respectively, the record-, block- and unit- separator.

Following separators are used:

TO SEPARATE A HEADER AND A BODY

Indicated as:	SRØ
Preferred: space	
Hexadecimal representation	20
Decimal representation	32

TO SEPARATE TWO UNITS (UNIT SEPARATOR)

The unit separator is used within a block to distinguish between related message units. However, it is quite usual that the header of the next unit implies the unit separator.

Indicated as:	SR1
Preferred: comma	,
Hexadecimal representation	2C
Decimal presentation	44

TO SEPARATE TWO BLOCKS OF UNITS (BLOCK SEPARATOR)

The block delimiter is used within a message to distinguish between message blocks. Also here it is common practice that the header of the next block implies the block separator if a message exclusively consists of blocks that only contain one message unit.

Indicated as:	SR2
Preferred: linefeed	LF
Hexadecimal representation	ØA
Decimal representation	10

TO TERMINATE THE LAST BLOCK TRANSMITTED (RECORD SEPARATOR)

The record separator is used to terminate a message. It indicates that there is no additional information available. In IEEE interfaces the END message is sent (via the ATN and the EOI-lines), concurrent with the NL message on the data bus.

Indicated as:	SR3
Preferred: linefeed + END	LF + END
Hexadecimal representation	ØA
Decimal representation	10

End activates the EOI interface management line.

5.4.3 Message unit

The message unit consists of:

HEADER indicating the type or quality of the data following in the body. They refer in general to the quantity of the data rather then to units.

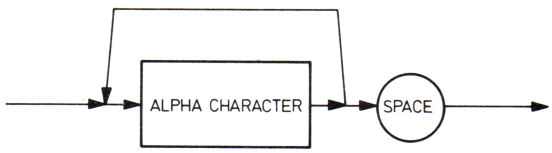

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Figure 5.2 Header

- Alpha characters are alpha numerical characters of the columns 4 and 5 of the ISO-code table, see section 7.3 (only upper case).
- The header defines which function we want to program in an oscilloscope.

BODY containing the data to be transferred. It may represent different data types.

5.5 OSCILLOSCOPE PROGRAMMING

An oscilloscope can be set in the local or in the remote states:

Local state : The operator can control the oscilloscope manually. (REMOTE segment in LCD off).
Remote state: The controller on the bus can control the oscilloscope. (REMOTE segment in LCD on).

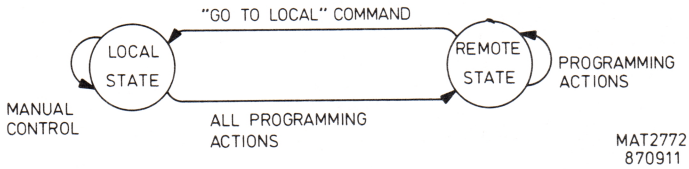


Figure 5.3 Two states of the osciloscope

In the oscilloscope we can devide the REMOTE state into two different states:

Front handling state : Used for programming a new acquisition setting.
Register handling state: Used for programming in stored settings and for data transfer. This function is typical for a digital storage oscilloscope.

The way to enter another state is to ask for that state.
However, there are exceptions.

- IEEE commands like GET, SDC and DCL result in the front handling state when coming from the local state.
- Coming from the local state, any programming action that is not preceeded by a new state request, is ending up in the front handling state.

Once in a certain state, a transition can only be made when a new state is programmed.

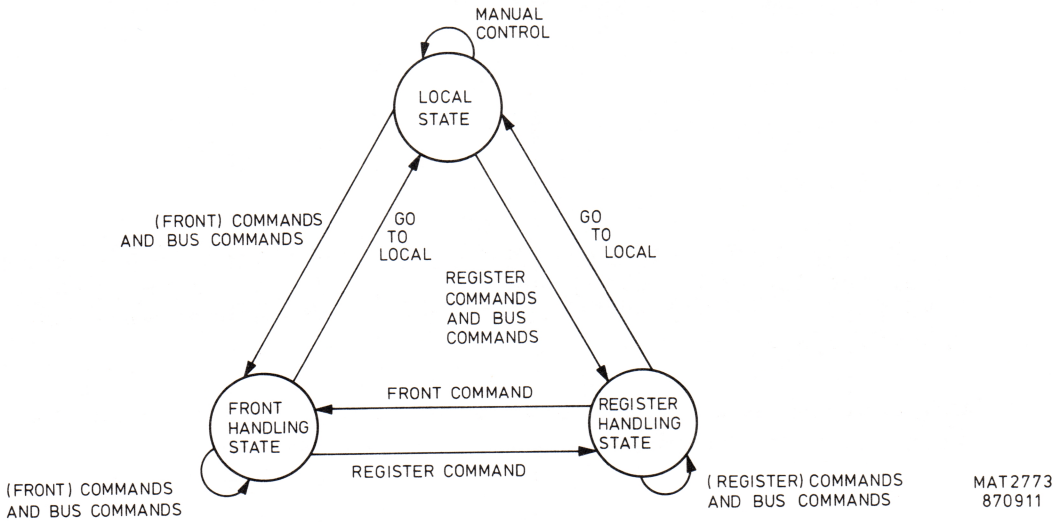


Figure 5.4 Oscilloscope states.

Commands between brackets are commands specific for that state.

- In the front handling state, we can change the actual settings of the oscilloscope.
- In the register handling state, we can change the stored settings.

Possible states within front and register handling state.

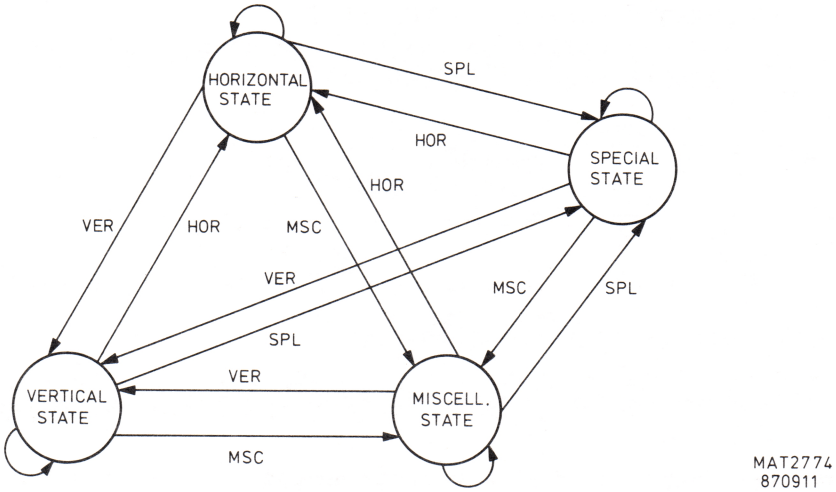


Figure 5.5 Detailed oscilloscope states.

Transition from one state to another can only occur if the command for entering that state is given.
For each oscilloscope function, which has to be programmed, first a SUPER FUNCTION must be selected, then a so-called MAIN FUNCTION and then one (or more) LOW FUNCTION(S).

So:

< HEADER > < BODY > < HEADER > < BODY > < HEADER > < BODY >

SP	USP	SP	USP	SP	SPR
SRØ	SR1	SRØ	SR1	SRØ	SR3

SUPER FUNCTION MAIN FUNCTION LOW FUNCTION

Example:

FRO	Ø	HOR	MTB	MGN	ON
SP	USP	SP	USP	SP	SPR

In this way the front panel is changed: time base magnification is switched on.

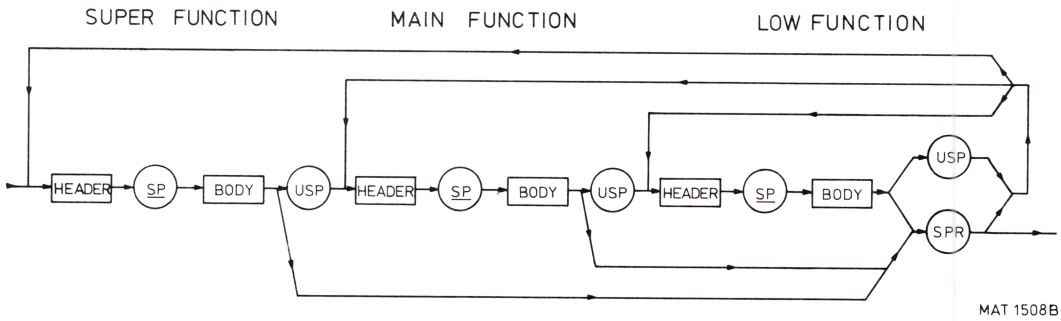


Figure 5.6 Programming structure

6. PROGRAMMING CODES

6.1 INTRODUCTION

This section deals with the code formats to be used for controlling the oscilloscope.

The codes are divided into a number of groups:

- SYSTEM CODES : Code for the programming of identity.
- SYSTEM INTERFACE CODES: Codes for the programming of separators and wait time delay.
- SUPER FUNCTION CODES : Codes for the transition to the register handling state or the front handling state.
- MAIN FUNCTION CODES : Codes for the transition within the register handling state or the front handling state.
- LOW FUNCTION CODES : Codes for the functions within a main function.
- DATA HANDLING CODES : Codes for the handling of the signal information which is stored in the digital memories. Data handling is a typical digital storage oscilloscope feature.
  A special group of programming codes is defined to read and write this information.
  Normally the signal data will be in NR1 notation. If data is transmitted in decimal notation, a multiple body can be used.

  ! Data handling can only be done in the register handling state.

  ! Data handling acts only on the data of the register which is currently selected by the bus.

NOTE: - It is always possible to use a "?" as a body. A "?" is defined for a bus controller to ask for information about a specific function. The answer from the oscilloscope will be, the header and the current situation (body or bodies).
- An error message occurs if a code is sent that is not implemented in the oscilloscope.

6.2 SYSTEM CODES

The following section describes the system codes to be used for programming.

6.2.1 Separator (SPR)

The SPR-command programs the RECORD SEPARATOR at the end of a record of a number of header/body combinations. The operator can program the RECORD SEPARATOR to which the oscilloscope will listen.
For output (from device to controller) this separator must be used.
For input (from controller to device) termination is on one of the following conditions:

- At receipt of the specified separator characters.
- Any other non printable ISO-code character.
- As preferred separator the default value is LF (0A Hex, 10 Dec).

NOTE: It is not allowed to use the ESC-character as a separator (1B Hex, 27 Dec).

The ISO-character is the RECORD SEPARATOR character itself which can be filled in by the operator/controller.
From the moment that the oscilloscope has interpreted this command sequence, it will only accept the defined character as a RECORD SEPARATOR at the end of a unit or a number of HEADER/BODY combinations.
The oscilloscope will then also send this character at the end of a record or a number of HEADER/BODY combinations.

The SPR-command is very useful when a controller does not know the LF as a RECORD SEPARATOR: with this instruction it can program the oscilloscope to listen to the RECORD SEPARATOR the controller does know and to send the RECORD SEPARATOR the controller does know.

Example: SPL INTERFACE,SPR 10 (see also section 6.3.3.4, Table XI).

6.2.2 Block separator (BSP)

The BLOCK SEPARATOR is the separator between the blocks of a unit.
The operator can program the block separator.
Only a single non printable ISO-character can be programmed, default value is LF (0A Hex, 10 Dec).

NOTE: It is not allowed to use the ESC-character as block separator (1B hex, 27 Dec).

The ISO-character is the BLOCK SEPARATOR character itself which can be filled in by the operator/controller.
From the moment that the oscilloscope has interpreted this command sequence, it will only acceptthe defined character as a BLOCK SEPARATOR at the end of a unit or a number of HEADER/BODY combinations.
The oscilloscope will then also send this character. The BLOCK SEPARATOR is used as separator in data-transfer.
When the oscilloscope is sending characters to the controller, after 200 characters a BSP is sent unconditional.

This command is very useful when a controller does not know the LF as a BLOCK SEPARATOR. With this instruction it can program the oscilloscope to listen to the BLOCK SEPARATOR the controller does know and to send the BLOCK SEPARATOR the controller does know.

Example: SPL INTERFACE,BSP 10 (see also section 6.3.3.4, Table XI).

6.2.3 Unit separator (USP)

The UNIT SEPARATOR is the separator between two units (header/body combinations). The operator can program the UNIT SEPARATOR to which the oscilloscope will listen.
Any, ISO character can be used to define the UNIT SEPARATOR. The default character is the COMMA (2C Hex, 44 Dec).

The ISO-character is the UNIT SEPARATOR character itself which can be filled in by the operator/controller.
From the moment that the oscilloscope has interpreted this command sequence, it will only accept the defined character as a UNIT SEPARATOR between the HEADER/BODY combinations.
The oscilloscope will then also send this character as SEPARATOR between two HEADER/BODY combinations.

This command is very useful when a controller does not know the COMMA as a UNIT SEPARATOR: with this instruction it is possible to program the oscilloscope to listen to the UNIT SEPARATOR the controller does know and to send the UNIT SEPARATOR the controller does know.

Example: SPL INTERFACE,USP 44 (see also section 6.3.3.4, Table XI).

6.2.4 Call for identitity (ID) (IDT)

The programmer can ask the PM number of the device and the used software release of the device and the option in use.

Following syntax is used:

ID(T)	?	Request for IDENTITY.
		Answer, returned from the oscilloscope will be:
		ID(T) PM.....Vxx usp PM.....Vyy
		Where xx defines the used software release of the oscilloscope and yy defines the used software release of the option.

6.2.5 Wait time delay (WTD)

For some controllers it is needed that the time between the transfer of two message blocks has to be stretched (only for IEEE).
The default value (after power up) is about 1.5 ms.

Example: SPL INTERFACE,WTD 12 (see also section 6.3.3.4, Table XI).

6.3 FUNCTION CODES

6.3.1 Super funcions

SUPER FUNCTIONs that can be selected for this oscilloscope:

Header:	Body:	Function:
FRO	?	Request for front panel selection Answer may be: FRO Ø or REG X (where "X" is the register number)
FRO	Ø	Select front panel
FRO	OFF	Switches off the selected front (same effect as REG Ø
REG	?	Request for register selection Answer may be: REG X or FRO Ø (where "X" is the register number)
REG	X	Selects the register X = Ø for RØ X = 1 for R1
REG	OFF	Switches off the selected register (same effect as FRO Ø)

6.3.2 Main functions

The frontpanel functions of this oscilloscope can be split-up into four MAIN FUNCTIONS.

VER ---> VERtical channels
HOR ---> HORizontal channel
MSC ---> MiSCellaneous
SPL ---> SPeciaL

MAIN FUNCTIONS valid for FRO Ø

Header:	Body:	Function:
VER	?	Request for vertical front panel settings.
VER	A	Selection of vertical channel A.
VER	B	Selection of vertical channel B.
VER	ADD	Selection of the ADD mode of the vertical channels (A + B).
HOR	?	Request for horizontal front panel settings.
HOR	MTB	Selection of the Main Time-Base.
HOR	EXD	Selection of the X-deflection.

Header:	Body:	Function:
MSC	?	Request for miscellaneous frontpanel settings.
MSC	AUX	Selection of miscellaneous auxiliary functions.
MSC	RØ	Selection of register Ø functions.
MSC	R1	Selection of register 1 functions.
SPL	?	Request for special mode settings. NOTE: The replay SPL INTERFACE will only be given when this function was selected in a previous stage.
SPL	CURSOR	Selection of the cursor functions.
SPL	TEXT	Selection of the text functions.
SPL	SERVICE	Selection of the service menu mode.
SPL	INTERFACE	Selection of the special interface functions.

MAIN FUNCTIONS valid for REG Ø or REG 1

Header:	Body:	Function:
VER	?	Request for vertical register settings.
VER	A	Selection of vertical channel A.
VER	B	Selection of vertical channel B.
HOR	?	Request for horizontal register settings.
HOR	MTB	Selection of the Main Time-Base.
MSC	?	Request for miscellaneous trace settings. NOTE: This request is only valid after an already selected MSC TRACE. Otherwise it gives an ERROR message.
MSC	TRACE	Selection of the trace functions.
SPL	?	Request for special mode settings. NOTE: this request is only valid after an already selected SPL INTERFACE. Otherwise it gives an ERROR message.
SPL	INTERFACE	Selection of the special interface functions.

For each MAIN FUNCTION there is a TABLE with so-called LOW FUNCTIONS which can be selected after the selection of the MAIN FUNCTION.
The next tables give a clear overview of the available low functions.

6.3.3 LOW functions

6.3.3.1 Main Function VER ...

TABLE I: Low functions valid for VER A or VER B

NOTE: The functions indicated with * are valid for FRO Ø, REG Ø and REG 1.
The functions without this indication are only valid for FRO Ø.

Header:	Body:	Function:
*FCN	?	Request for state of main function Answer may be : FCN ON or FCN OFF
*FCN	ON	Selected channel ON --> active state
*FCN	OFF	Selected channel OFF --> INactive state
*ATT	?	Request for actual input sensitivity Answer may be: 2E-03 (2 mV/div) 5E-03 (5 mV/div) 10E-03 (10 mV/div) 20E-03 (20 mV/div) 50E-03 (50 mV/div) .1E+00 (.1 V/div) .2E+00 (.2 V/div) .5E+00 (.5 V/div) 1E+00 (1 V/div) 2E+00 (2 V/div) 5E+00 (5 V/div) 10E+00 (10 V/div)

NOTE: The given answer represents the input sensitivity of the oscilloscope without the influence of a connected attenuator probe.

*ATT	XXESYY	Input sensitivity can be programmed: values for XXESYY as mentioned above between 2E-03 (2mV/div) and 10E+00 (10V/div).
*PRO	?	Request for connected probe Answer may be: PRO 1, PRO 10 or PRO 100. (Only valid when a probe with range indication is used otherwise PRO1 will be returned)
SET	?	Request for state of AUTO SET mode. Answer will be: SET INACTIVE
SET	AUT	Command for AUTO SET procedure.
SET	STANDARD	Command to call the STANDARD setting.

Header:	Body:	Function:
*CPL	?	Request for coupling of the selected channel. Answer may be : CPL DC, CPL AC, CPL ZERO,
CPL	DC	Selected channel is DC coupled.
CPL	AC	Selected channel is AC coupled
CPL	ZERO	Input of selected channel is set to ZERO
ALT	?	Request for state of alternate display mode. Answer may be ALT ON or ALT OFF.
ALT	ON	Alternate function ON.
ALT	OFF	Alternate function OFF.
CHP	?	Request for state of chopped display mode. Answer may be CHP ON or CHP OFF.
CHP	ON	Chopped function ON.
CHP	OFF	Chopped function OFF.
INV	?	Request for inversion of channel B. Answer may be: INV ON or INV OFF.
INV	ON	Invert function active for channel B.
INV	OFF	Invert function INactive for channel B.
RDY	?	Request for state of time base. Answer may be: YES if the time base has received a trigger pulse and is not ready to start upon receipt of a trigger pulse. Answer may be: NO if not received a trigger pulse yet.
VAR	?	Request for the absolute position of the variable gain setting of the selected channel. The answer may be: VAR CAL or VAR LOCAL.
VAR	CAL	The variable gain control is put in the calibrated position (knob turned fully clockwise). This is only possible in the REMOTE state.
VAR	LOCAL	The variable gain control is set to LOCAL, user can use the function manually.
*CAL	?	Request for state of VAR control of selected channel. Answer may be ON for calibrated control or OFF for uncalibrated control.

Header:	Body:	Function:
POS	?	Request for the absolute position of the horizontal shift. Answer may be: POS SXXXX or POS LOCAL. "S" represents the sign (- or +), "XXXX" represents the value and can be between -8192 (means knob fully counter clockwise) and +8191 (means knob fully clockwise).
POS	SXXXX	The shift position is set to the absolute position, represented by the number SXXXX.
POS	LOCAL	The shift position is set to LOCAL, user can use the function manually.

Table II: Low functions valid for VER ADD

Header:	Body:	Function:
FCN	?	Request for state of main function Answer may be : FCN ON or FCN OFF
FCN	ON	Selected channel ON --> active state
FCN	OFF	Selected channel OFF --> INactive state
SET	?	Request for state of AUTO SET mode. Answer will be: SET INACTIVE
SET	AUT	Command for AUTO SET procedure.
SET	STANDARD	Command to call the STANDARD setting.
ALT	?	Request for state of alternate display mode. Answer may be ALT ON or ALT OFF.
ALT	ON	Alternate function ON.
ALT	OFF	Alternate function OFF.
CHP	?	Request for state of chopped display mode. Answer may be CHP ON or CHP OFF.
CHP	ON	Chopped function ON.
CHP	OFF	Chopped function OFF.
RDY	?	Request for state of time base. Answer may be: YES if the time base has received a trigger pulse and is ready to start upon receipt of a trigger pulse. Answer may be: NO if not received a trigger pulse yet.

6.3.3.2 Main function HOR ...

Table III: Low functions valid for HOR MTB

NOTE: The functions indicated with * are valid for FRO Ø, REG Ø and REG 1.
The functions without this indication are only valid for FRO Ø.

Header:	Body:	Function:
FCN	?	Request for state of main function. Answer may be: FCN ON or FCN OFF. FCN OFF is only valid for X deflection.
FCN	ON	Main function ON or active
*TIM	?	Request for actual time base sweep speed. Answer may be: 50E-09 (50 ns/div) .1E-06 (0,1 µs/div) .2E-06 (0,2 µs/div) .5E-06 (0,5 µs/div) 1E-06 (1 µs/div) 2E-06 (2 µs/div) 5E-06 (5 µs/div) 10E-06 (10 µs/div) 20E-06 (20 µs/div) 50E-06 (50 µs/div) .1E-03 (100 µs/div) .2E-03 (0,2 ms/div) .5E-03 (0,5 ms/div) 1E-03 (1 ms/div) 2E-03 (2 ms/div) 5E-03 (5 ms/div) 10E-03 (10 ms/div) 20E-03 (20 ms/div) 50E-03 (50 ms/div) .1E+00 (0,1 s/div) .2E+00 (0,2 s/div) .5E+00 (0,5 s/div) 1E+00 (1 s/div) (roll mode) 2E+00 (2 s/div) (roll mode) 5E+00 (5 s/div) (roll mode) 10E+00 (10 s/div) (roll mode) 20E+00 (20 s/div) (roll mode) 50E+00 (50 s/div) (roll mode)

NOTE: - The given answer represents the sweep speed of the oscilloscope without the influence of the TB MAGNifier.
- When in PLOT mode, every new setting of the time base will restart the acquisition.

*TIM	XXESYY	Time-base setting can be programmed: values for XXESYY as mentioned above between 50E-09 and 50E+00

Header:	Body:	Function:
ROLL	?	Request for the ROLL mode. Answer will be: ROLL TRIGGERED.
ROLL	TRIGGERED	Starts the acquisition when in ROLL mode. The ROLL mode is stopped by a trigger signal. The triggered stop can be delayed by selecting a trigger delay. Each new selection of this function function will restart the triggered ROLL mode.
*TRD	?	Request for trigger delay. Answer is: TRD SXXX. "S" represents the sign (- or +), "XXX" represents the value and can be between -10 ... +250. NOTE: The time base magnifier is not taken in account.
TRD	SXXX	The trigger delay (DIV) can be set to the value represented by the number SXXX, where XXX is the number of divisions. NOTE: When in ROLL mode every new setting of the trigger delay will restart the acquisition.
SET	?	Request for state of AUTO SET mode. Answer will be: SET INACTIVE
SET	AUT	Command for AUTO SET procedure.
SET	STANDARD	Command to call the STANDARD setting.
*TRG	?	Request for state of Trigger mode selection Answer may be: TRG AUT, TRG TRI, TRG SNG or TRG MUL.
TRG	AUT	AUTO FREE-RUN mode
TRG	TRI	Triggered mode
TRG	SNG	SINGLE shot mode. NOTE: "TRG SNG" will reset the time base.
TRG	MUL	Multiple trigger mode.
RDY	?	Request for state of time base. Answer may be YES if the time base has received a trigger pulse and is not ready to start upon receipt of a trigger pulse. Answer may be NO if not received a trigger pulse yet.

Header:	Body:	Function:
*TSO	?	Request for state of trigger source. Answer may be: TSO A, TSO B, TSO COM, TSO EXT or TSO LINE.
TSO	A	Trigger signal derived from channel A.
TSO	B	Trigger signal derived from channel B.
TSO	COM	Trigger signal derived from the composite trigger signals of channel A and channel B
TSO	EXT	Trigger signal derived from the external input.
TSO	LINE	Trigger signal derived from the line frequency NOTE: can only be selected for HOR MTB.
*TSL	?	Request for state of the trigger slope Answer may be: TSL POS or TSL NEG
TSL	POS	Triggering on the positive going slope of the trigger signal.
TSL	NEG	Triggering on the negative going slope of the trigger signal.
*CPL	?	Request for state of trigger coupling. Answer may be: CPL PEAK, CPL DC, CPL TVF or CPL TVL.
CPL	PEAK	Triggering Peak Peak coupled.
CPL	DC	Triggering DC coupled.
CPL	TVF	Triggering coupled for TV frame pulse recognition.
CPL	TVL	Triggering coupled for TV line pulse recognition.
*EXT	?	Request for state of external coupling. Answer may be: EXT AC or EXT DC.
EXT	AC	External input is AC coupled.
EXT	DC	External input is DC coupled.
MGN	?	Request for state of TB MAGN function. Answer may be: MGN ON or MGN OFF
MGN	ON	TB MAGN ON (active)
MGN	OFF	TB MAGN OFF (inactive)

Header:	Body:	Function:
LEV_VIEW	?	Request for state of LEVEL VIEW. Answer may be: LEV_VIEW ON or LEV_VIEW OFF.
LEV_VIEW	ON	LEVEL VIEW function ON.
LEV_VIEW	OFF	LEVEL VIEW function OFF.
VAR	?	Request for the absolute position of the variable gain setting of the time base. Answer may be: VAR CAL or VAR LOCAL.
VAR	CAL	The variable gain control is put in the calibrated position (knob turned fully clockwise). This is only possible in the REMOTE state.
VAR	LOCAL	The variable gain control is set to LOCAL, user can use the knob manually.
CAL	?	Request for state of VAR control of time base. Answer may be ON for calibrated control or OFF for uncalibrated control.
LEV	?	Request for state of LEVEL. Answer may be: LEV SXXXX or LEV LOCAL. "S" represents the sign (- or +). "XXXX" represents the value and can be between -8192 ... +8191.
LEV	SXXXX	The trigger level is set to the absolute value, represented by the number SXXXX.
LEV	LOCAL	The variable LEVEL control is set to LOCAL, user can use the knob manually.
HLO	?	Request for the absolute position of the HOLD OFF setting. ANSWER may be: HLO CAL or HLO LOCAL.
HLO	CAL	The HOLD OFF control is put in the calibrated position (knob turned fully clockwise). This is only possible in the REMOTE state.
HLO	LOCAL	The HOLD OFF control is set to LOCAL, user can use the knob manually.

Table IV: Low function valid for HOR EXD

Header:	Body:	Function:
FCN	?	Request for state of main function. Answer may be: FCN ON or FCN OFF.
FCN	ON	Main function ON or active
FCN	OFF	Main function OFF or INactive
SET	?	Request for state of AUTO SET mode. Answer will be: SET INACTIVE
SET	AUT	Command for AUTO SET procedure.
XCH	?	Request for state of X-deflection source. Answer may be: XCH A, XCH B, XCH EXT, or XCH LINE.
XCH	A	Command for X-deflection via trigger source A.
XCH	B	Command for X-deflection via trigger source B.
XCH	EXT	Command for X-deflection via external trigger input.
XCH	LINE	Command for X-deflection via the LINE trigger signal.
INV	?	Request for state of X DEFL polarity.
INV	ON	Horizontal deflection by X DEFL is inverted.
INV	OFF	Horizontal deflection by X DEFL is not inverted.
EXT	?	Request for state of external coupling. Answer may be: EXT AC or EXT DC.
EXT	AC	External input is AC coupled.
EXT	DC	External input is DC coupled.

6.3.3.3 Main function MSC ...

Table V: Low functions valid for MSC AUX

Header:	Body:	Function:
SET	?	Request for state of AUTO SET mode. Answer will be: SET INACTIVE
SET	AUT	Command for AUTO SET procedure.
SET	STANDARD	Command to call the STANDARD setting.
RDY	?	Request for state of time base. Answer may be YES if the time base has received a trigger pulse and is not ready to start upon receipt of a trigger pulse. Answer may be NO if not received a trigger pulse yet.
MEM	?	Request for state of digital storage mode. Answer may be: MEM ON or MEM OFF.
MEM	ON	Digital storage mode ON.
MEM	OFF	Real time mode ON.
LCK	?	Request for LOCK state. Answer may be: LCK ON or LCK OFF.
LCK	ON	Digital memory is locked.
LCK	OFF	Display is not locked and can be refreshed.
CLR	?	Request for clear state. Answer may be: CLR ON or CLR OFF.
CLR	ON	Clears register RØ until the function CLR OFF is programmed.
CLR	OFF	Stop clearing register RØ.
PART	?	Request for selected display part. Answer will be: PART XX. "XX" represents the value and can be between 1 and 63.
PART	XX	Display part can be programmed, values for "XX" as mentioned above. NOTE: selection of display part depends on the MGN setting, in formula: max. PART XX= PART (MGN * 2).

Header:	Body:	Function:
MGN	?	Request for state of horizontal magnification. Answer will be: MAGN XX. "XX" represents the value and can be 1, 2, 4, 8, 16 or 32.
MGN	XX	Horizontal magnification can be programmed: values for "XX" as mentioned above.
DOT	?	Request for the DOT state. Answer may be DOT ON or DOT OFF.
DOT	ON	Display of only dots.
DOT	OFF	DOT joined display.
SCREENPLOT	?	Request for the state of the screenplot function. Answer may be: SCREENPLOT ANALOG or SCREENPLOT OFF.
SCREENPLOT	ANALOG	Selection and start of the analog screenplot action.
SCREENPLOT	OFF	The current screenplot action stops.
PLOTTIME	?	Request for the current plottime. Answer will be: PLOTTIME XXXX. "XXXX" represents the selected plottime per dot in ms. (ms/dt) and can be between 20 and 2000.
PLOTTIME	XXXX	Plottime can be set in ms/dot: values for "XXXX" as mentioned above.
PENUP	?	Request for the penlift state. Answer may be: PENUP Ø or PENUP 1.
PENUP	Ø	Selection of a low level TTL signal on the penlift output.
PENUP	1	Selection of a high level TTL signal on the penlift output.
XPOS	?	Request for the absolute position of the vertical shift. Answer may be: XPOS CALL or XPOS LOCAL,
XPOS	CALL	The horizontal position is set to the pre-defined position. This is only in the REMOTE state.
XPOS	LOCAL	The horizontal position is set to LOCAL, user can use the knob manually.

Table VI: Low functions for MSC RØ or R1.

Header:	Body:	Function:
SET	?	Request for state of AUTO SET mode. Answer will be: SET INACTIVE
SET	AUT	Command for AUTO SET procedure.
SET	STANDARD	Command to call the STANDARD setting.
RDY	?	Request for state of time base. Answer may be YES if the time base has received a trigger pulse and is not ready to start upon receipt of a trigger pulse. Answer may be NO if not received a trigger pulse yet.
SEL	?	Request for the state of the register. Answer may be: SEL A or SEL B.
SEL	A	Assigns the Y POS to the A channel of the selected register.
SEL	B	Assigns the Y POS to the B channel of the selected register.
DSP	?	Request for the display state. Answer may be: DSP ON or DSP OFF.
DSP	ON	The display of the selected register is switched ON.
DSP	OFF	The display of register RØ or R1 is switched OFF.
SETTING_TEXT	?	Request for the SETTING_TEXT state. Answer may be: SETTING_TEXT ON or SETTING_TEXT OFF.
SETTING_TEXT	ON	The vertical and horizontal setting information of the selected register is displayed in the upper side of the screen.
SETTING_TEXT	OFF	The vertical and horizontal setting information is not displayed on the screen.
SAV	?	Request for state of the save function (R1 only). Answer will be: SAV OFF.
SAV	ON	The contents of RØ is saved in register R1.

Header:	Body:	Function:
RYPOS	?	Request for the relative vertical position of the signal of the selected register. Answer will be: RYPOS SXXX. "S" represents the sign (- or +), "XXX" represents the value and can be between -255 and +255.
RYPOS	SXXX	The vertical position is set to the relative position. "SXXX is the number over which the stored trace can be shifted over the screen. At the moment that the trace is stored (loaded) into the register, the relative position is set to Ø.

Table VII: Low functions valid for MSC TRACE

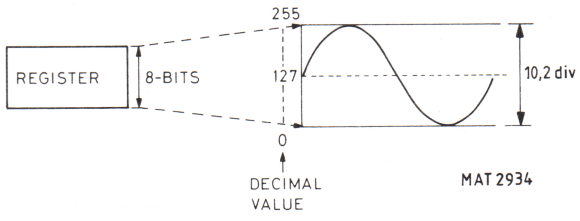
Header:	Body:	Function:
CHANNEL	?	Request for the selected channel(S). Answer may be: CHANNEL A, CHANNEL B or CHANNEL ALL.
CHANNEL	A	Selection of channel A for data transfer.
CHANNEL	B	Selection of channel B for data transfer,
CHANNEL	ALL	Selection of the complete register contents for data transfer.
PRT	?	Request for the state of the PART function. Answer may be: PRT REAL or PRT ALL.
PRT	REAL	Selects only the measured samples which belong to the selected channel(s) in the register for data transfer. The oscilloscope will always start the transfer by sending DAT followed by the number of samples which can be expected to be transferred.
PRT	ALL	Selects the measured and the interpollated samples which belong to the selected channel(s) on the register for data transfer.
BGN	?	Request for the begin address. Answer will be: BGN SXXXX. "S" represents the sign (+), "XXXX" represents the value and can be Ø ... +4095.
BGN	SXXXX	Selection of the register begin address for data transfer: values for "SXXXX" as mentioned above.

Header:	Body:	Function:
END	?	Request for the end address. Answer will be: BGN SXXXX. "S" represents the sign (+), "XXXX" represents the value and can be Ø ... +4095.
END	SXXXX	Selection of the register begin address for data transfer: values for "SXXXX" asd mentioned above.
CNT	?	Request for the count factor. Answer will be: BGN SXXXX. "S" represents the sign (+), "XXXX" represents the value and can be Ø ... +4095.
CNT	SXXXX	Selection of the count (or resolution) factor for data transfer: values for "SXXXX" as mentioned above.
DATA_TYPE	?	Request for the selected data type. Answer may be: DATA_TYPE DECIMAL or DATA_TYPE BINARY.
DATA_TYPE	DECIMAL	Selection of data transfer in decimal values. These decimal values are separated for each other block by block separators. The string is terminated by a separator. Format: DAT YYYY bsp XXXX bsp XXXX ... XXXX spr where YYYY is the number of decimal values to be transferred and XXXX is a decimal value between Ø and +255 in the selected data type. "bsp" is a block separator and "spr" is a separator.
DATA_TYPE	BINARY	Selection of data transfer in binary values. Format: DAT Y bsp #B<H><L><D><D> ... <D><C> spr where Y is the number of data words to be transferred. The first high and low order byte (H=high byte and L=low byte) combination after #B contains the number of bytes to be transferred in binary notation. Then follows a number of combinations of bytes each containing a data word <D>. The last byte "C" contains a checksum byte which is calculated over all data bytes except the two lenght bytes which are transferred after #B. Each data word is an unsigned integer.
DAT	?	Request for data (of the selected register) from the oscilloscope. The format of the answer is the same as decribed under DATA_TYPE DECIMAL and DATA_TYPE BINARY.
DAT	....	Transfer data to the oscilloscope. The format of the string to be sent has to be the same as derscribed under DATA_TYPE DECIMAL and under DATA_TYPE BINARY.

Maximum available points for data transfer:

TIME/DIV	SINGLE CHANNEL MODE		DUAL CHANNEL MODE			
			CHANNEL ALL		CHANNEL A or B	
	PRT REAL	PRT ALL	PRT REAL	PRT ALL	PRT REAL	PRT ALL
.5 us	512	1024	1024	2048	512	1024
1 us	512	1024	1024	2048	512	1024
2 us	512	1024	1024	2048	512	1024
5 us	512	1024	1024	2048	512	1024
10 us	512	1024	1024	2048	512	1024
20 us	512	1024	1024	2048	512	1024
50 us	512	1024	1024	2048	512	1024
.1 ms	512	1024	1024	2048	512	1024
.2 ms	512	1024	1024	2048	512	1024
.5 ms	512	1024	1024	2048	512	1024
1 ms	512	1024	1024	2048	512	1024
2 ms	512	1024	1024	2048	512	1024
5 ms	4096	4096	4096	4096	2048	2048
10 ms	4096	4096	4096	4096	2048	2048
20 ms	4096	4096	4096	4096	2048	2048
50 ms	4096	4096	4096	4096	2048	2048
.1 s	4096	4096	4096	4096	2048	2048
.2 s	4096	4096	4096	4096	2048	2048
.5 s	4096	4096	4096	4096	2048	2048
1 s	4096	4096	4096	4096	2048	2048
2 s	4096	4096	4096	4096	2048	2048
5 s	4096	4096	4096	4096	2048	2048
10 s	4096	4096	4096	4096	2048	2048
20 s	4096	4096	4096	4096	2048	2048
50 s	4096	4096	4096	4096	2048	2048

Vertical



Horizontal

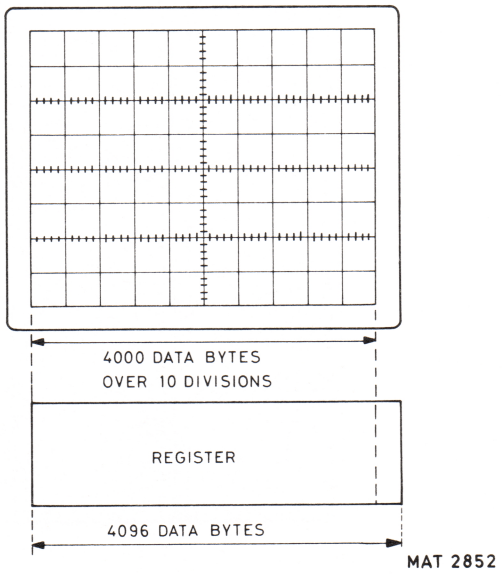


Figure 6.1 Register contents versus display

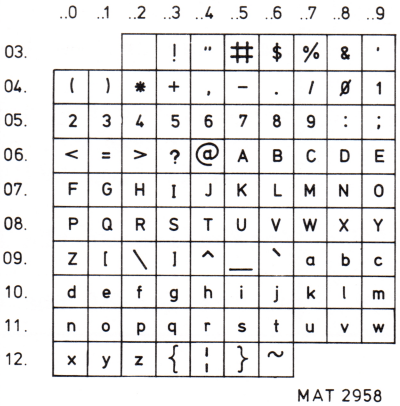
6.3.3.4 Main function SPL...

Table VIII: Low functions valid for SPL CURSOR

Header:	Body:	Function:
FCN	?	Request for state of main function. Answer may be: FCN ON or FCN OFF.
FCN	ON	Main function ON or active
FCN	OFF	Main function OFF or INactive
SET	?	Request for state of AUTO SET mode. Answer will be: SET INACTIVE
SET	AUT	Command for AUTO SET procedure.
SET	STANDARD	Command to call the STANDARD setting.
RDY	?	Request for state of time base. Answer may be YES if the time base has received a trigger pulse and is not ready to start upon receipt of a trigger pulse. Answer may be NO if not received a trigger pulse yet.
FIRST	?	Request for the absolute value of the horizontal position of the first cursor. Answer may be: FIRST XXXX. "XXXX" represents a value between and can be Ø ... 4095.
FIRST	XXXX	The horizontal position of the first cursor is set to the absolute value: values for "XXXX" as mentioned above.
SECOND	?	Request for the absolute value of the horizontal position of the second cursor. Answer may be: SECOND XXXX. "XXXX" represents a value between and can be Ø ... 4095.
SECOND	XXXX	The horizontal position of the second cursor is set to the absolute value: values for "XXXX" as mentioned above.
CUR	?	Request for the register for which the cursors are displayed. Answer may be: CUR RØ or CUR R1.
CUR	XX	Selection of the register for which the cursors have to be displayed. "XX" represents RØ or R1.

Header:	Body:	Function:
SEL	?	Request for the selected channel. Answer may be: SEL A or SEL B.
SEL	A	The cursors are displayed on channel A of the selected register.
SEL	B	The cursors are displayed on channel B of the selected register.
DVOLT	?	Request for the measured dV value. Answer will be: DVOLT XXESYY.
DTIME	?	Request for the measured dt value. Answer will be: DTIME XXESYY.
PEAK	?	Request for the measured p-p value. Answer will be: PEAK XXESYY.
PEAK	ON	Switches on the p-p voltage measurement.
PEAK	OFF	Switches off the p-p voltage measurement.
RISE	?	Request for the measured rise time measurement. Answer will be: RISE XXESYY.
RISE	ON	Switches on the rise time measurement.
RISE	OFF	Switches off the rise time measurement.
FREQ	?	Request for the measured frequency value. Answer may be: FREQ XXESYY or FREQ ERROR.
FREQ	ON	Switches on the frequency measurement.
FREQ	OFF	Switches off the frequency measurement.
INV_DTIME	?	Request for the measured 1/dt value. Answer may be: INV_DTIME XXESYY or INV_DTIME ERROR.
INV_DTIME	ON	Switches on the 1/dt measurement.
ACQUISITION	?	Request for the acquisition state. Answer may be: ACQUISITION RESTART or ACQUISITION RETURN.
ACQUISITION	RESTART	Activation of the RESTART function.
ACQUISITION	RETURN	Activation of the REVERSE function.

Table IX: Low functions valid for SPL TEXT

Header:	Body:	Function:
FCN	?	Request for state of main function. Answer may be: FCN ON or FCN OFF.
FCN	ON	Main function ON or active. FCN ON selects the main menu.
FCN	OFF	Main function OFF or INactive This clears always the current text on the screen.
SET	?	Request for state of AUTO SET mode. Answer will be: SET INACTIVE
SET	AUT	Command for AUTO SET procedure.
SET	STANDARD	Command to call the STANDARD setting.
RDY	?	Request for state of time base. Answer may be YES if the time base has received a trigger pulse and is not ready to start upon receipt of a trigger pulse. Answer may be NO if not received a trigger pulse yet.
TEXT	X	"X" is a string with ASCII characters, which form together the usertext to be displayed on the screen in the selected text area.
CHAR	?	Request for the last programmed special character. Answer will be: CHAR INACTIVE. "XXX" represents a number (32 ... 126).
CHAR	X	This command followed by one or more decimal numbers results in text or figures written into one or more screen positions. The decimal numbers must be separated by a unit separator (multiple body construction). The decimal figures result in the characters and figures as given in the table below.  MAT 2958

Header:	Body:	Function:
LINE	?	Request for the current textline. Answer may be: LINE Ø or LINE 1.
LINE	Ø	Selection of the top textline.
LINE	1	Selection of the bottom textline.
OWNER	?	Request for the current owner state.
OWNER	OSC	Oscilloscope sets the softkey text in the previous selected line on the screen.
OWNER	USER	User can set any text on the screen in the previous selected line.
COLUMN	?	Request for the current text column. Answer may be: COLUMN XX. "XX"represents a number between Ø and 39.
COLUMN	XX	Selection of one of the fourty available horizontal columns Ø ... 39.

Table X: Low functions valid for SPL SERVICE

Header:	Body:	Function:
SET	?	Request for state of AUTO SET mode. Answer will be: SET INACTIVE
SET	AUT	Command for AUTO SET procedure.
SET	STANDARD	Command to call the STANDARD setting.
RDY	?	Request for state of time base. Answer may be YES if the time base has received a trigger pulse and is not ready to start upon receipt of a trigger pulse. Answer may be NO if not received a trigger pulse yet.

Header:	Body:	Function:
SERVICE	?	Request for the state of the service menu. Answer may be: SERVICE X.XX or SERVICE OFF. "X.XX" represents the selected service menu.
SERVICE	0.0	Selects the main service menu.
SERVICE	1.0	Selects the applications menu.
SERVICE	2.0	Selects the brief checking procedure, DC input coupling. NOTE: Each step of this menu can be switched on directly or can be found by one or more SERVICE UP or SERVICE DOWN actions.
SERVICE	2.1	AC input coupling.
SERVICE	2.2	Roll mode.
SERVICE	2.3	Display part x1.
SERVICE	2.4	Display part x8.
SERVICE	2.5	Display part x32.
SERVICE	2.6	Trigger delay 0 div.
SERVICE	2.7	Pre-trigger 6 div.
SERVICE	2.8	Trigger delay 94 div.
SERVICE	2.9	Multi display A+B.
SERVICE	2.10	Register display.
SERVICE	2.11	Dotted display.
SERVICE	2.12	Locked display.
SERVICE	3.0	Selects the offset menu for adjusting the oscilloscope, adjusting R 1036 (R 1136). NOTE: Each step of this menu can be switched on directly or can be found by one or more SERVICE UP or SERVICE DOWN actions.
SERVICE	3.1	Adjusting R 1064 (R 1164).
SERVICE	3.2	Adjusting R 1072 (R 1172).
SERVICE	3.3	Adjusting R 1091.
SERVICE	3.4	Adjusting R 1191.
SERVICE	3.5	Adjusting R 1217.
SERVICE	3.6	Adjusting R 2212.
SERVICE	3.7	Adjusting R 3007.
SERVICE	4.0	Selects display menu for adjusting the oscilloscope, adjusting R 550. NOTE: Each step of this menu can be switched on directly or can be found one or more SERVICE UP or SERVICE DOWN actions.
SERVICE	4.1	Adjusting R 542.
SERVICE	4.2	Adjusting R 601.
SERVICE	4.3	Adjusting R 606.
SERVICE	4.4	Adjusting R 553.
SERVICE	5.0	WATCHDOG test menu and the service menu is leaved.

Header:	Body:	Function:
SERVICE	UP	Performance of the NEXT function within a selected service menu.
SERVICE	DOWN	Performance of the PREVIOUS function within a selected service menu.
SERVICE	OFF	The oscilloscope leaves the service menu again and starts the SOFTSTART procedure. NOTE: After leaving the service menu, the USP must be defined again (see Section 6.2.1).
SOFTKEY	?	Request for the last used CRT softkey number and its status. Answer may be: SOFTKEY OSC or SOFTKEY USER.
SOFTKEY	OSC	Switches all the CRT softkeys back to the oscilloscope again.
SOFTKEY	USER	Switches all the CRT softkeys for definition by the user. The CRT softkeys generate a service request on the bus and the status word gives the value 65, 66, 67, 68 or 69 depending on what softkeys is depressed.
KEY	?	Request for the status of the last used key. Answer may be: KEY ON, KEY OFF or KEY INACTIVE. This is only possible when SOFTKEY USER has already selected.

ATTENTION: To assure the proper use of the SOFTKEY and KEY functions, the oscilloscope has to be in the REMOTE state.

Table XI: Low functions valid for SPL INTERFACE

ATTENTION: To assure the proper operation a waittime of 1 s approx. must be programmed when changing a function in this mode.

Header:	Body:	Function:
SET	?	Request for state of AUTO SET mode. Answer will be: SET INACTIVE
SET	AUT	Command for AUTO SET procedure.
SET	STANDARD	Command to call the STANDARD setting.
RDY	?	Request for state of time base. Answer may be YES if the time base has received a trigger pulse and is not ready to start upon receipt of a trigger pulse. Answer may be NO if not received a trigger pulse yet.

Header:	Body:	Function:
ADDRESS	?	Request for the current address state. Answer will be: ADDRESS XX. "XX" represents any number between Ø and 30.
ADDRESS	XX	Sets the IEEE to the new selected value, represented by the number "XX".
TL_MODE	?	Request for the current TL_MODE state. Answer may be: TL_MODE TO or TL_MODE TL.
TL_MODE	LO	Sets the oscilloscope to the LISTEN ONLY state.
TL_MODE	TO	Sets the oscilloscope to the TALK ONLY state.
TL_MODE	TL	Sets the oscilloscope to the TALKER/LISTENER state.
SPR	?	Request for the value of the RECORD SEPARATOR. ANSWER will be: SPR XX. "XX" represents any number between Ø and 31 (decimal equivalent), except 27 (ESC).
SPR	XX	Sets the RECORD SEPARATOR to the new selected value, represented by the number "XX".
BSP	?	Request for the value of the BLOCK SEPARATOR. Answer will be: BSP XX. "XX" represents any number between Ø and 31 (decimal equivalent>, except 27 (ESC).
BSP	XX	Sets the BLOCK SEPARATOR to the new selected value, represented by the number "XX".
USP	?	Request for the value of the UNIT SEPARATOR. Answer will be: USP XXX. "XXX" represents any number between Ø and 255, except 27 (ESC).
USP	XXX	Sets the UNIT SEPARATOR to the new selected value, represented by the number "XXX". It is also possible to set the UNIT SEPARATOR directly, by typing the desired character on your keyboard. USP / will set the UNIT SEPARATOR to / (slash)-(2F Hex, 47 Dec).
WTD	?	Request for the WAIT TIME DELAY. Answer may be: WTD SXXXXX or WTD OFF. "S" represents the sign (+), "XXXXX" represents the programmed wait time and can be between Ø and +32767. NOTE: The returned WDT has always to be increased with the internal delay of 1,5 ms. WDT 12 = 13,5 ms
WTD	SXXXXX	The WAIT TIME DELAY after a transfer of a message block is set to the value defined by the number "SXXXXX". The delay is inserted after a BSP or an SPR.

7. PROGRAMMING INFORMATION

7.1 SERVICE REQUEST (SRQ) + STATUS WORD

7.1.1 General

The oscilloscope is able to send an active SRQ on the bus to indicate a special condition of the instrument. Also the RQS-bit of the device status word is set.

A request for service is given if:

- The oscilloscope indicates a fault (for example if an incorrect programming code has been received).
- The oscilloscope has data ready to be read by the controller.
- The softkey status changes and the softkeys are defined by the user.

After the controller has indicated that the SRQ line is active, the controller can do a SERIAL POLL action to find out why the SRQ line is activated by the oscilloscope.
The controller can address the oscilloscope as "serial poll talker", after which the device status word is set on the Bus lines (DIO8...DIO1) by the oscilloscope.

The SRQ-message is automatically reset after acknowledge from the controller. Via SERIAL POLL (1. and 2.) or reading the data.

7.1.2 Reading the device status word of the oscilloscope

The status word can be read by programming a SERIAL POLL action.

- Send UNListen.
- Send SPE (Serial Poll Enable).
- Make the oscilloscope TALKER.
- Make controller LISTENER.
- Read STATUS-word.
- Send UNTalk.
- Send SPD (Serial Poll Disable).

7.1.3 The STATUS-word of the oscilloscope

The device dependent bits in the status word specify the reasons for service request and / or reflect the status of the device functions.

The status word can have a few different values:

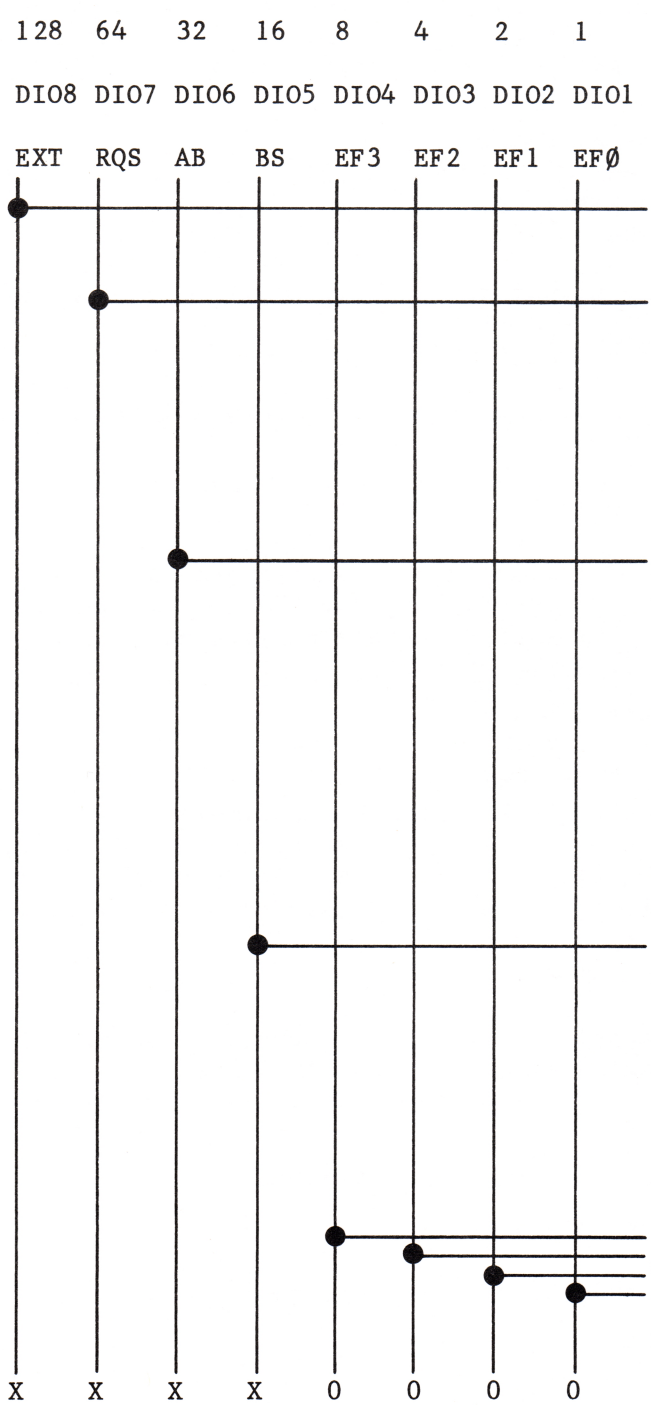
Ø : nothing of interest is happening.
1 : programming error.
4 : valid data is on the bus (used during transfer).
8 : input buffer full.
16 : the oscilloscope is busy with a programmed measurement.
32 : something is wrong : ABNORMAL.
64 : the oscilloscope has an active service request.

There can also be a combination of these basic values.

Possible values of the status word for this instrument are given below:

65 : Service request with CRT softkey 1 pressed or released.
66 : Service request with CRT softkey 2 pressed or released.
67 : Service request with CRT softkey 3 pressed or released.
68 : Service request with CRT softkey 4 pressed or released.
69 : Service request with CRT softkey 5 pressed or released.
97 : Programming error.
100 : Data ready to be transferred.
104 : Input buffer of oscilloscope full (only in case that no separator is received).

The device STATUS-word (8 bits) from the oscilloscope is built up as follows:



: Extension bit:
This bit is not used and is always "Ø".

: Service request bit:
RQS = Ø:
No request for service is given.
RQS = 1:
A request for service has been given by the oscilloscope.

: Abnormal bit:
AB = Ø
No erroneous or alarm condition detected.
The status is specified in the bits EF3 - EFØ.
AB = 1
The oscilloscope is in an erroneous or alarm condition. The fault condition is specified in the bits EF3 - EFØ.

: Busy bit:
BS = Ø
The oscilloscope is not measuring (ready with programmed action).
BS = 1
The oscilloscope is measuring (busy with programmed action).

: Bits EF3 - EFØ Error code:

AB = Ø	AB = 1
normal	normal
	programming fault
	internal error
	data ready to be transferred
	input buffer full

7.2 MULTI LINE MESSAGES (WITH ATN TRUE)

7.2.1 GO TO LOCAL command

There are four ways to get the oscilloscope out of the remote situation and these are:

- hardware reset (power off, power on).
- via an IEEE bus command GTL (Go To Local).
- by de-activating the REN line.
- by IFC (interface clear).

To get the oscilloscope out of its current remote situation send:

X0000001 (with ATN true)

After executing this command the oscilloscope is listening again to the knobs at the frontpanel.

7.2.2 GROUP EXECUTE TRIGGER command

It is possible for the controller to tell the oscilloscope to get in the remote situation by using the IEEE bus GET (Group Execute Trigger) command, provided that the IEEE interface management line REN (Remote Enable) is true. This is done by sending:

X0001000 (with ATN true)

During GET the status will be 16.
There will be a service request after the measurement is ready. This service request will stay active until the status of the oscilloscope is loaded into the controller. After this, the service request is resetted by the oscilloscope and can be enabled by a new GET command.

7.2.3 SELECTIVE DEVICE CLEAR command

The oscilloscope is capable of receiving and executing an SDC (Selective Device Clear) command from the IEEE bus.
The controller sets the oscilloscope in the selective device clear state by sending:

Device listener address followed by:

X0000100 (with ATN true)

On receiving this command the oscilloscope will execute the following:

* Execution of AUTO SET

7.2.4 DEVICE CLEAR command

The oscilloscope is capable of receiving and executing a DCL (Device Clear) command from the IEEE bus.
The controller sets all the devices in the system in the device clear state by sending:

X0010100 (with ATN true)

On receiving this command the oscilloscope will execute the following:

* Execution of AUTO SET.

COLUMN →		0			1			2			3			4			5			6			7		
ROW ↓	b7 → b6 → b5 →	0 0 0			0 0 1			0 1 0			0 1 1			1 0 0			1 0 1			1 1 0			1 1 1		
	b4 b3 b2 b1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1
0	0 0 0 0	NUL	0		DLE	16		SP	32	0	0	48	16	@	64	0	P	80	16	`	96		p	112	
1	0 0 0 1	SOH	1	GTL	DC1	17	LLO	!	33	1	1	49	17	A	65	1	Q	81	17	a	97		q	113	
2	0 0 1 0	STX	2		DC2	18		"	34	2	2	50	18	B	66	2	R	82	18	b	98		r	114	
3	0 0 1 1	ETX	3		DC3	19		#	35	3	3	51	19	C	67	3	S	83	19	c	99		s	115	
4	0 1 0 0	EOT	4	SDC	DC4	20	DCL	$	36	4	4	52	20	D	68	4	T	84	20	d	100		t	116	
5	0 1 0 1	ENQ	5	PPC	NAK	21	PPU	%	37	5	5	53	21	E	69	5	U	85	21	e	101		u	117	
6	0 1 1 0	ACK	6		SYN	22		&	38	6	6	54	22	F	70	6	V	86	22	f	102		v	118	
7	0 1 1 1	BEL	7		ETB	23		'	39	7	7	55	23	G	71	7	W	87	23	g	103		w	119	
8	1 0 0 0	BS	8	GET	CAN	24	SPE	(	40	8	8	56	24	H	72	8	X	88	24	h	104		x	120	
9	1 0 0 1	HT	9	TCT	EM	25	SPD	)	41	9	9	57	25	I	73	9	Y	89	25	i	105		y	121	
10 A	1 0 1 0	LF	10		SUB	26		*	42	10	:	58	26	J	74	10	Z	90	26	j	106		z	122	
11 B	1 0 1 1	VT	11		ESC	27		+	43	11	;	59	27	K	75	11	[	91	27	k	107		{	123	
12 C	1 1 0 0	FF	12		FS	28		,	44	12	<	60	28	L	76	12	\	92	28	l	108		|	124	
13 D	1 1 0 1	CR	13		GS	29		–	45	13	=	61	29	M	77	13	]	93	29	m	109		}	125	
14 E	1 1 1 0	SO	14		RS	30		.	46	14	>	62	30	N	78	14	^	94	30	n	110		~	126	
15 F	1 1 1 1	SI	15		US	31		/	47	15	?	63	UNL	O	79	15	_	95		o	111		DEL	127	

ADDRESSSED COMMAND GROUP

UNIVERSAL COMMAND GROUP

LISTEN ADDRESS GROUP

TALK ADDRESS GROUP

SECONDARY ADDRESS GROUP

8. PROGRAMMING EXAMPLES

8.1 INTRODUCTION

This chapter gives a number of driver programs and programming examples for a number of different controllers. These controllers are:

HP85
P2000C
IBM

During all programs it is assumed that the IEEE device address of the oscilloscope is set to Ø8.

8.2 DRIVER PROGRAMS

This Chapter gives a simple driver program of which the listings are given below. It is able to send commands from the controllers' keyboard to the oscilloscope. In case that the command incorporates a question mark (?), the answer given by the oscilloscope is displayed on the screen of the controller. The commands are stored in the string A$. If the command is STOP, the oscilloscope goes to LOCAL again. An answer from the oscilloscope to the controller is stored in the reply string R$.

The program works correctly if the oscilloscope is set as talker and listener and if the address is set to Ø8.

8.2.1 Driver program HP85

```
 10 ! DRIVER FOR SCOPES
 20 LOCAL 7
 30 CONTROL 7,16 ; 1,10
 40 CLEAR
 50 P=708
 60 CLEAR
 70 DISP "UNIVERSAL DRIVER FOR S
    COPES"
 80 DISP "----------------------
    -----"
 90 DISP "YOU CAN TYPE IN THE CO
    MMANDS"
100 DISP "AFTER 'next command'"
110 DISP " "
120 DISP "TYPE RETURN TO PROCEED
    "
130 INPUT L$
140 BEEP
150 OUTPUT P USING "K" ; "SPL IN
    TERFACE"
160 OUTPUT P USING "K" ; "INTF I
    EEE488 Ø"
170 OUTPUT P USING "K" ; "SPR 10
    "
180 OUTPUT P USING "K" ; "USP 47
    "
190 CLEAR
200 DISP " "
210 DIM R$[1024]
220 DIM Q$[2048]
230 DIM A$[128]
240 Q$=" "
250 A$="SET AUT"
260 GOTO 350
270 S=Ø
280 S1=Ø
290 R$=" "
300 DISP
310 DISP "next command: ";
320 INPUT A$
330 IF A$="STOP" THEN GOTO 530
340 IF LEN(A$)=Ø THEN CLEAR @ GO
    TO 300
350 OUTPUT P USING "K" ; A$
360 CLEAR
370 S1=SPOLL(P)
380 DISP "done:  ";A$;"        st
    atus:";S1
390 DISP "----------------------
    ---------"
400 IF S1=98 THEN GOTO 560
410 IF S1=97 THEN GOTO 580
420 IF S1=100 THEN GOTO 440
430 GOTO 270
440 ENTER P ; R$
450 Q$=Q$&R$
460 DISP "LEN =";LEN(R$);" - ";N
    UM(R$[LEN(R$),LEN(R$)])
470 IF LEN(R$)>222 THEN ENTER P
    ; R$@ Q$=Q$&R$ @ GOTO 470
480 DISP "REPLY= ";Q$ @ Q$=""
490 GOTO 270
500 DISP
510 DISP "NO REPLY"
520 GOTO 270
530 DISP "END"
540 END
550 BEEP 50,100
560 DISP "INTERFACE ERROR"
570 GOTO 270
580 DISP "PROGRAMMING ERROR"
590 GOTO 270
600 CLEAR
610 DISP ""
620 DISP "END"
630 DISP "==="
640 BEEP
650 END
```

8.2.2 Driver program IBM

```
10 REM ************************************************************************
20 '
30 '                          UNIVERSAL DRIVER FOR 3100
40 '
50 '
60 '                         REL DATE:86-10-02
70 '                         SOFTWARE SUPPORT GROUP
80 REM ************************************************************************
90 'Copyright 1986, N.V. Philips Gloeilampenfabrieken
```

```
┌──────────────────────────────────────────────────────┐
│                                                      │
│                                                      │
│  D E C L A R A T I O N   P A R T (decl.bas)           │
│                                                      │
│                                                      │
└──────────────────────────────────────────────────────┘
```

```
570 '
580 CLS
590 ' START APPLICATION PROGRAM AFTER THIS LINE
600 '
610 AD=708   'scope adress=8
620 ADP=7    'adapter nr=7
630 SC=1     'adapter is sytem controller
640 CON=7:STATUS=30
650 MAX=255
660 TIME=5
670 CALL IOABORT(ADP)
680 CALL IORESET(ADP)
690 CALL IOINIT(AD,SC)
700 CALL IOCLEAR(AD)
710 CALL IOTIMEOUT(ADP,TIME)
720 CALL IOCONTROL(ADP,CON,STATUS)
730 PRINT "************************************************************************"
740 INPUT "COMMAND: ";WR$
750 IF LEFT$(WR$,2)="st" OR LEFT$(WR$,2)="ST" THEN 1010
760 LE=LEN(WR$)
770 CALL IOOUTPUTS(AD,WR$,LE)
780 GOSUB 910
790 GOSUB 930
800 IF STATUS<>100 THEN 730
810 PRINT "REPLY FROM SCOPE:"
820 PRINT "-----------------"
830 INFO$=SPACE$(MAX):RDNR=0
840 CALL IOENTERS(AD,INFO$,MAX,RDNR)
850 GOSUB 910
860 PRINT LEFT$(INFO$,RDNR);
870 IF RDNR>223 THEN GOTO 830
880 GOSUB 930
890 IF RDNR<255 THEN 730 ELSE 830
900 REM ************************************************************************
910 IF PCIB.ERR<>0 THEN PRINT PCIB.ERR$
920 RETURN
930 REM ********************** SERIAL POLL *********************************
940 FOR Q=1 TO 100:NEXT Q
950 CALL IOSPOLL(AD,STATUS)
960 PRINT "SERIAL POLL: ",STATUS
970 IF STATUS = 97 THEN PRINT "PROGRAMMING ERROR"
980 IF STATUS =98 THEN PRINT "INTERNAL ERROR"
990 GOSUB 910
1000 RETURN
1010 CALL IOLOCAL(AD)
1020 CLS:END
```

8.2.3 Driver program P2000C

```
10 PRINT CHR$(12)
20 PRINT "******************  P2000_ SCOPE DRIVER  *************************"
30 PRINT:PRINT:PRINT
40 IEC INIT
50 REM ---- IEC-ADDRESS :
60 ADR=8
70 DIM R$(1512),B$(500)
80 DIM A$(128)
100 IEC PRINT #ADR,"USP /"
110 PRINT
120 PRINT "----------------------------------------------------------------"
130 PRINT
140 S=0
150 S1=0
160 R$=" "
170 INPUT A$
180 IF A$="stop" THEN GOTO 310
190 IF A$="rest" THEN 260
200 IEC PRINT #ADR,A$
210 FOR I= 1 TO 200
220 NEXT I
230 IEC POLL #ADR,S1
240 PRINT "Serial poll=";S1
250 IF S1<>64 THEN GOTO 300
260 IEC INPUT #ADR,R$
270 PRINT "reply=";R$
280 GOTO 230
290 PRINT "no reply"
300 GOTO 110
310 PRINT "end"
320 END
330 IEC POLL #8,P
340 PRINT P
350 END
```

8.3 HOW TO USE THE DRIVER PROGRAMS?

Just type in these programs in your controller and run them.
The program asks you to enter commands as described in chapter 6.

Example: (IBM)

When the program is executed, the interface is cleared, set to a predefined status, and the oscilloscope performs an autoset.

The screen is cleared (line 580) and the controller asks you to enter a command:

COMMAND: ?

Then you can enter your command after the ? mark, and after typing return the oscilloscope returns its statusword (SERIAL POLL:...) and/or the data you asked for.

(Example) MSC ?

```
**********************************************************************
COMMAND: msc ?
SERIAL POLL:   100
REPLY FROM SCOPE:
----------------
MSC R0,SET INACTIVE,RDY NO,DSP ON,SEL A,RYPOS 0,SETTING_TEXT OFF,MSC R1,SET INAC
TIVE,RDY NO,SAV OFF,DSP OFF,SEL A,RYPOS 0,SETTING_TEXT OFF,MSC AUX,SET INACTIVE,
MGN 1,RDY NO,MEM OFF,DOT OFF,LCK OFF,CLR OFF,XPOS CAL,PENUP 1,PLO
TTIME 200,SCREENPLOT OFF,PART 1
SERIAL POLL:   0
**********************************************************************
COMMAND:
```

Example: (HP85)

When the program is executed, first some interface parameters are set: the SPR is set to LF and the USP to / (slash).

The controller will then ask you to give your command.

NEXT COMMAND: ?

Then you can enter your command and after typing a return the oscilloscope returns its statusword and/or the data you asked for.

(Example) HOR ?

```
done:  HOR ?        status: 100
-------------------------------
LEN = 205  -  67
REPLY=
HOR MTB,CAL ON,VAR LOCAL,FCN ON,
CPL PEAK,SET INACTIVE,LEV LOCAL,
TIM 1E-03,TSO A,TSL POS,MGN OFF,
TRD 0,TRG AUT,RDY NO,HLO LOCAL,E
XT AC,ROLL OFF,LEV_VIEW OFF,HOR
EXD,FCN OFF,INV OFF,SET INACTIVE
,XCH A,EXT AC

next command: ?
```

8.4 EXAMPLE PROGRAMS

8.4.1 Introduction

This Chapter gives example programs with the following sections:

- Oscilloscope initialisation
- Text generation
- Data transfer
- Position correction via digital potentiometers.

Figure 8.1 gives a flow-chart for these programs.

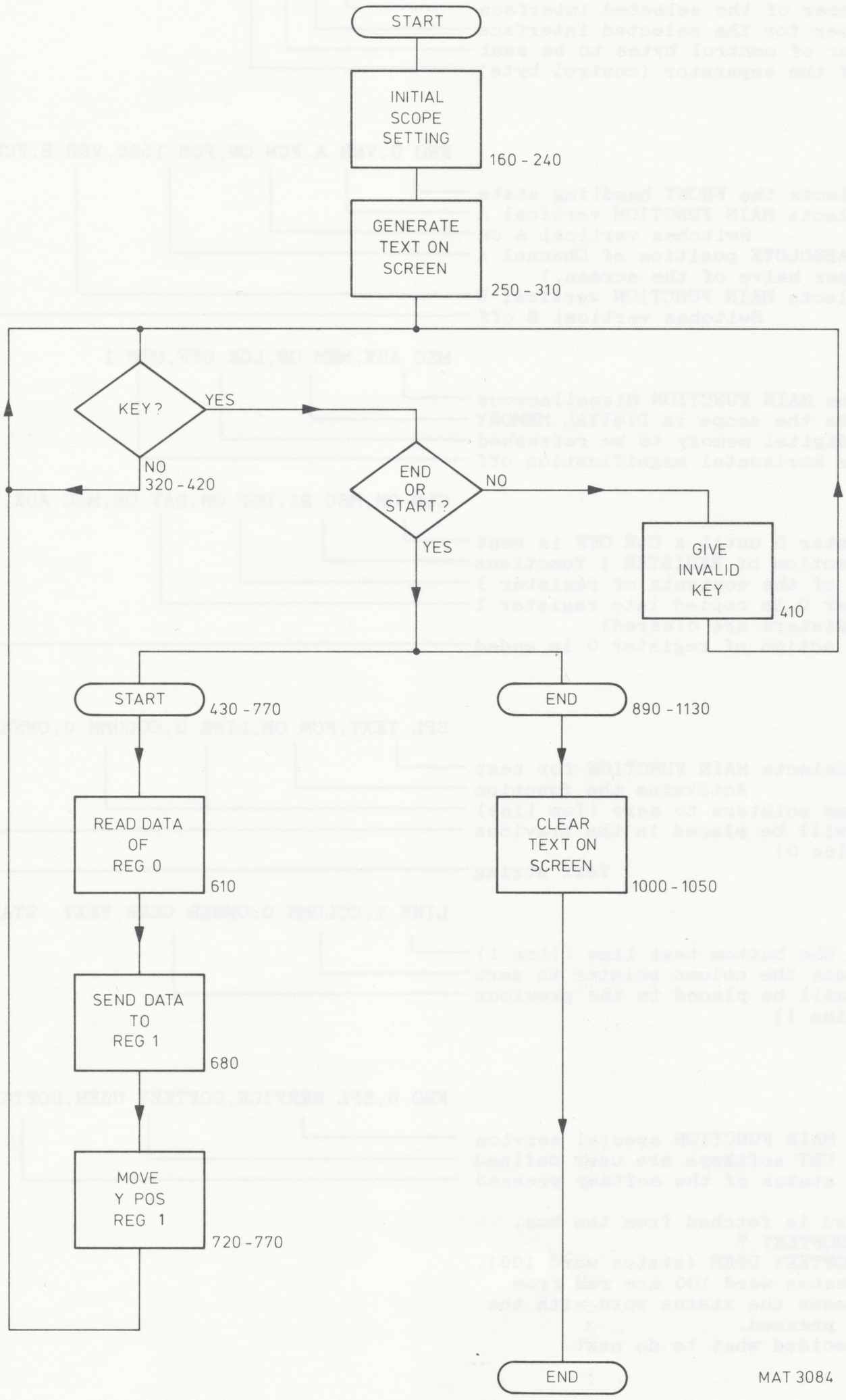


Figure 8.1 Flow-chart for fast data transfer

These programs works correctly if the oscilloscope is set as talker and listener and if the address is set to Ø8.

8.4.2 Example program for HP85

```
 10 CLEAR
 20 REM ************************
 30 REM *                      *
 40 REM * FAST DATA TRANSFER   *
 50 REM *                      *
 60 REM ************************
 70 REM
 80 REM Software Support Group
 90 REM
100 REM              871104
110 REM
120 DIM Z$[20480]
130 DIM A$[512]
140 IOBUFFER Z$
150 CONTROL 7,16 ; 1,10
160 REM ----------------------
170 REM SCOPE INITIALISATION
180 REM ----------------------
190 A$="FRO 0,VER A,FCN ON,POS 1
    500,VER B,FCN OFF"
200 GOSUB 810
210 A$="MSC AUX,MEM ON,LCK OFF,M
    GN 1"
220 GOSUB 810
230 A$="CLR ON,MSC R1,DSP ON,SAV
     ON,MSC AUX,CLR OFF"
240 GOSUB 810
250 REM --------------------
260 REM TEXT GENERATION
270 REM --------------------
280 A$="SPL TEXT,FCN ON,LINE 0,,
    COLUMN 0,OWNER USER,TEXT   *
    * E X A M P L E    P R O G R
     A M **"
290 GOSUB 810
300 A$="LINE 1,COLUMN 0,OWNER US
    ER,TEXT START     (press a s
    oftkey)          END"
310 GOSUB 810
320 REM --------------------
330 REM WAIT FOR KEYPRESS
340 REM --------------------
350 A$="FRO 0,SPL SERVICE,SOFTKE
    Y USER,SOFTKEY ?"
360 GOSUB 810
370 S=SPOLL(708)
380 IF S=100 THEN 830
390 IF S=65 THEN 430
400 IF S=69 THEN 890
410 IF S=66 OR S=67 OR S=68 THEN
     DISP "INVALID KEY  : ";S
420 GOTO 370
```

PROGRAM DESCRIPTION

Following is assumed; The address of the PM3350 is 8
The separator is a linefeed
The unit separator is a comma

LINE 10

Clears the screen of the HP85 controller.

LINE 20-110

Remarks, used to indicate goal and programming date of the program.

LINE 120-140

String variables, used further on in the programm are dimensioned.
Z$ is used as the IOBUFFER, the buffer where the transferred data points will be stored.
A$ is used as a string variable to keep the text to send to the PM3350.

LINE 150

```
CONTROL 7,16;1,10
```

- The number of the selected interface
- Register number for the selected interface
- Number of control bytes to be sent
- Decimal representation of the separator (control byte)

LINE 160-240

SCOPE INITIALISATION

```
FRO 0,VER A,FCN ON,POS 1500,VER B,FCN OFF
```

- Selects the FRONT handling state
- Selects MAIN FUNCTION vertical A
- Switches vertical A on
- Shifts the ABSOLUTE position of Channel A to 1500 (upper halve of the screen.)
- Selects MAIN FUNCTION vertical B
- Switches vertical B off

```
MSC AUX,MEM ON,LCK OFF,MGN 1
```

- Selects the MAIN FUNCTION Miscellaneous
- Sets the scope in DIGITAL MEMORY
- Enables the digital memory to be refreshed
- Switches horizontal magnification off

```
CLR ON,MSC R1,DSP ON,SAV ON,MSC AUX,CLR OFF
```

- Clears register 0 until a CLR OFF is sent
- Enables selection of REGISTER 1 functions
- Selects the display of the contents of register 1
- The contents of register 0 is copied into register 1 (at this point both registers are cleared)
- The clear action of register 0 is ended

LINE 250-310

TEXT GENERATION

```
SPL TEXT,FCN ON,LINE 0,COLUMN 0,OWNER USER,TEXT  ****
```

- Selects MAIN FUNCTION for text
- Activates the function
- Set the line and column pointers to zero (Top line)
- The text (user text) will be placed in the previous selected text line (line 0)
- Text string

```
LINE 1,COLUMN 0,OWNER USER,TEXT  START .....
```

- Selects the bottom text line (line 1)
- Sets the column pointer to zero
- The text (user text) will be placed in the previous selected text line (line 1)

LINE 320-420

WAIT FOR KEYPRESS

```
FRO 0,SPL SERVICE,SOFTKEY USER,SOFTKEY ?
```

- Selects MAIN FUNCTION special service
- CRT softkeys are user defined
- Request for the status of the softkey pressed

In line 370 the status word is fetched from the bus.
After the request of the SOFTKEY ?
The PM3350 replies with SOFTKEY USER (status word 100).
After the reply and the status word 100 are red from the bus, the scope also sends the status word with the key number of the softkey pressed.
In the lines 380-410 is decided what to do next.

```
430 REM --------------------          LINE    430-690
440 REM START DATA TRANSFER
450 REM --------------------
460 BEEP
470 DISP "----------------------
    ---------"
480 DISP "       T R A N S F E R
     ! !    "
490 FOR Q=1 TO 10
500 NEXT Q
510 S=SPOLL(708)
520 IF S<>0 THEN 510
530 A$="REG 0,MSC TRACE,BGN 0,EN
    D 4095,CNT 1,DATA_TYPE BINAR
    Y"
540 GOSUB 810
550 A$="DAT ?"
560 GOSUB 810
570 S=SPOLL(708)
580 DISP "STATUS
    :";S
590 IF S<>100 THEN 570
600 ENTER 708 ; D$
610 TRANSFER 708 TO Z$ FHS ; EOI
620 FOR Q=1 TO 10
630 NEXT Q
640 A$="REG 1,MSC TRACE"
650 GOSUB 810
660 OUTPUT 708 USING "K" ; D$
670 CONTROL 7,16 ; 0,0
680 TRANSFER Z$ TO 708 FHS
690 BEEP
700 DISP "----------------------
    ---------"
710 CONTROL 7,16 ; 1,10
720 REM --------------------
730 REM POSITION CORRECTION
740 REM --------------------
750 A$="FRO 0,MSC R1,RYPOS -100"
760 GOSUB 810
770 GOTO 320                          LINE    720-770
780 REM --------------------
790 REM SEND STRING TO PM3350
800 REM --------------------
810 OUTPUT 708 USING "K" ; A$
820 RETURN
830 REM --------------------
840 REM READ STRING FROM PM3350       LINE    780-820
850 REM --------------------
860 ENTER 708 ; D$
870 DISP "GARBAGE STRING :";D$
880 GOTO 370
890 REM --------------------
900 REM END ROUTINE                   LINE    830-880
910 REM --------------------
920 DISP "----------------------
    ---------"
930 DISP "           E N D
          "
940 FOR Q=1 TO 100                    LINE    890-1130
950 NEXT Q
960 S=SPOLL(708)
970 DISP "STATUS IN END ROUTINE
    ";S
980 IF S=100 THEN 830
990 IF S<>0 THEN 940
1000 A$="SPL TEXT,FCN ON,LINE 0,
     ,COLUMN 0,OWNER USER,TEXT
                    "
1010 GOSUB 810
1020 A$="LINE 1,COLUMN 0,OWNER U
     SER,TEXT
                              "
1030 GOSUB 810
1040 A$="SPL SERVICE,SOFTKEY OSC
     "
1050 GOSUB 810
1060 LOCAL 708
1070 DISP "----------------------
     ----------"
1080 BEEP
1090 DISP ""
1100 DISP "         R E A D Y
          "
1110 END
```

DATA TRANSFER

Just before this routine is entered, a key was pressed.
The status word of the pressed key is given twice; once at key-press and once at key-release.
Lines 470,500 ensure a short delay(release time of the pressed key).
Lines 510,520 fetch the key-release status word from the bus.

```
REG 0,MSC TRACE,BGN 0,END 4095,CNT 1,DATA_TYPE BINARY
Selects REGISTER handling state for register 0
     Selects MAIN FUNCTION for Trace functions
               Sets begin, end and count values
                   Selects Binary data transfer
```

```
DAT ?
```

The actual transfer is started after the receipt of the separator,(delimiter, sent after the question mark.)
Lines 570,590 wait until the status word is 100, to indicate the start of the transfer.
Line 600 fetches the first part of the total data transfer;
The scope sends :DAT ####, where #### is the number of bytes to be transferred.
In line 610 binary data is fetched in Fast Handshake mode, and stored in Z$.
Lines 620,630 are necessary for internal rearrangements in the PM3350.
If you ommit this short delay, it may happen that the next commands to the PM3350 are not recognized.

```
REG 1,MSC TRACE
Selects REGISTER handling state for register 1
     Selects MAIN FUNCTION for Trace functions
```

In line 660, the previous fetched number of data points is returned to the PM3350, to indicate that #### of datapoints will be returned to the memory of register 1
Line 680 returns the binary data points from the IOBUFFER Z$ to the PM3350.

POSITION CORRECTION OF REGISTER 1

```
FRO 0,MSC R1,RYPOS -100
                Selects FRONT handling state
          Enables selection of register 1 functions
Changes the relative position of register 1 display
```

SEND STRING TO SCOPE SUBROUTINE

This routine is called every time a previous prepared text string has to be sent to the scope.
The text is in the string variable A$.

READ STRING FROM PM3350 SUBROUTINE

This routine is a kind of garbage collection routine, to fetch the PM3350 replies from the bus we don't use.
For user convenience it is displayed on the controllers screen.

END ROUTINE

Lines 940,990 ensure that the key-release status is fetched from the bus and the eventually garbage is removed.

```
SPL TEXT,FCN ON,LINE 0,COLUMN 0,OWNER USER,TEXT
                Selects MAIN FUNCTION special text
          Set line and column pointers to zero
The text will be placed in the previous selected
text line (line 0)
               Empty text string (40 spaces)
```

```
LINE 1,COLUMN 0,OWNER USER,TEXT
                Selects the bottom text line
          Sets the column pointer to zero
The text will be placed in the previous selected
text line (line 1)
               Empty text string (40 spaces)
```

```
SPL SERVICE,SOFTKEY OSC
Selects MAIN FUNCTION special service
     CRT softkeys are SCOPE softkeys
```

Line 1060 sets the scope to local again.

9. CIRCUIT DESCRIPTION

The IEEE unit A11 mainly consists of :

- IEEE bus interface
- Decoders
- Potentiometer switches

9.1 IEEE BUS INTERFACE

This circuit contains the IEEE Talker/Listener chip D116 and four bidirectional IEEE bus transceivers D117, D118, D119 and D121.

D116 handles the communication between the microprocessor and the IEEE-488 interface bus and implements all of the standard's interface functions except for the controller.
The most important connections are:

* DATA bus port DØ...D7 (pin 12...pin 19).
* Register select inputs RSØ...RS2 (pin 21...pin 23).
  Select which of the eight internal read/write registers will be read from/written into with the execution of control signal RD-LT (pin 9) or WR-LT (pin 10).
* Chip select input (pin 8).
  When LOW, enables reading from or writing into the register, selected by RSØ...RS2.
* READ input (pin 9) and WRITE input (pin 10).
  When LOW with IEEE-LT LOW (pin 8), selected register contents are read or data is written.
* DATA bus port DIØØ...DI07 (pin 28...pin 35).
  Used for bidirectional data byte transfer between D116 and the IEEE-488 bus.
* IEEE handshake control lines.
  - DAV, Data valid (pin 36)
  - NRFD, Not ready for data (pin 37)
  - NDAC, Not data accepted (pin 38)
* IEEE interface management lines.
  - ATN, Attention (pin 26)
  - SRQ, Service request (pin 27)
  - IFC, Interface clear (pin 24)
  - EOI, End or identify (pin 39)
  - REN, Remote enable (pin 25)
* Tranceiver control lines TR1 (pin 1) and TR2 (pin 2).
  Used to determine the mode of behaviour of the tranceivers D117...D120, whether they are input or output. TR1 HIGH indicates an active source handshake, TR1 LOW indicates an active acceptor handshake. TR2 LOW indicates an expected input signal on the EOI line during parallel poll.

The four IEEE Tranceivers D117, D118, D119 and D121 interface D116 directly to the IEEE-488 bus.

9.2 DECODERS

The decoders D101 and D102 decode the address lines A0, A1 and A2 into the DLEN (Data Latch Enable) lines according to the next table:

Line	address (Hex)
SW0	C0000
SW1	C0001
SW2	C0002
SW3	C0003
SW4	C0004
SW5	C0005
SW6	C0006
SW7	C0007
DLPA	D0000
DLPB	D0001
DLPX	D0002
DLLV	D0003

D104 and D106 convert the TTL output of D102 into the SW0...SW7 signals which are at a high voltage CMOS level.

9.3 POTENTIOMETER SWITCHES

* DA converters:

  The digital-to-analog converters (DAC) N102...N106 convert the digital information of the potentiometer controls for POS A, POS B and LEVEL on the SDA input into an analogue current (pin 22). In turn, this current is converted into a voltage via N101. The voltage range is 0...+10 V. These four voltage outputs are applied to the multiplexers D112...D114.

* Multiplexers:

  Depending on the level of SWØ...SW7, the control lines to the different circuit can be influenced by the analogue potentiometers at the front of the instrument (when SWØ...SW7 is low) or by the IEEE bus (when SWØ...SW7 is high). POS A, POS B and LEVEL can digitally controlled over the complete range via the IEEE bus. Next the POS X is set to the mid-position, while the four other potentiometers VAR A, VAR B, VAR X and HOLD OFF are set in their CAL position.

9.4 SIGNAL NAME LIST

Signal name	Description	Signal source	Signal destination(s)
A0...2	Address bus lines	D214	D101 - D116
ATN	Attention	D119	X102
D0...7	Data bus	D214	D116
DACCS-LT	Digital analog conversion chip select	D213	D101
DAV	Data valid	D119	X102
DHOFF	Digital hold off	D114	R4301
DGPTCS-LT	Digital potmeters chip select	D213	D102
DIO1...8	Data bus IEEE	D117/D118	X102
DLEVEL	Digital level	D114	R2369
DLLV	Data latch enable level	D101	N106
DLPA	Data latch enable position A	D101	N102
DLPB	Data latch enable position B	D101	N103
DLPX	Data latch enable position X	D101	N104
DOI01...08	Data bus IEEE	D116	D117 - D118
DPOSA	Digital position ch. A	D112	R2201
DPOSB	Digital position ch. B	D112	R2206
DPOSX	Digital position X	D113	R4722
DVARA	Digital variable ch. A	D112	R1084
DVARB	Digital variable ch. B	D113	R1184
DVARX	Digital variable X	D113	R4101
EOI	End or identify	D121	X102
HOFF	Hold off	N7002	D114
IEEECLK	IEEE clock	D204	D116
IEEECSLT	IEEE chip select	D201	D116
IFC	Interface clear	D121	X102
LEVEL	Level	N7003	D114
NDAC	Not data accepted	D119	X102
NRFD	Not ready for data	D119	X102
POS A	Position ch. A	N7003	D112
POS B	Position ch. B	N7002	D112
POS X	Position X	N7003	D113 - R560
READ-LT	Read signal	D217	D116
REN	Remote enable	D121	X102
RESET-LT	Reset	V208	R191 - D214 - D318
SCL0	Serial clock 0	D223	D221 - N102
SDA0	Serial data 0	D223	D221 - N102
SRQ	Service request	D121	X102
SW0...7	Switches 0...7	D104/D106	D112 - D113 - D114
VAR A	Variable ch. A	N7002	D112
VAR B	Variable ch. B	N7003	D113
VAR X	Variable X	N7002	D113
WRITE-LT	Write signal	D213	D116 - D217 - D218

10. PARTS LIST

(subject to alteration without notice)

Capacitors

POSNR	DESCRIPTION	ORDERING CODE
	DIL SOCKET 32-P	5322 255 40829
	RIB CABLE CON	5322 267 70175
C 0101	10% 1NF	4822 122 30027
C 0102	-20+50% 10NF	4822 122 31414
C 0103	-20+50% 10NF	4822 122 31414
C 0104	10% 1NF	4822 122 30027
C 0105	-20+50% 10NF	4822 122 31414
C 0106	63V 10% 100NF	5322 121 43083
C 0107	63V 10% 100NF	5322 121 43083
C 0108	63V 10% 100NF	5322 121 43083
C 0109	63V 10% 100NF	5322 121 43083
C 0110	-20+50% 10NF	4822 122 31414
C 0111	63V 10% 100NF	5322 121 43083
C 0112	-20+50% 10NF	4822 122 31414
C 0113	-20+50% 10NF	4822 122 31414
C 0114	-20+50% 10NF	4822 122 31414
C 0116	-20+50% 10NF	4822 122 31414
C 0117	-20+50% 10NF	4822 122 31414
C 0118	10% 1.5NF	4822 122 31169
C 0119	63V 10% 100NF	5322 121 43083
C 0121	10% 1NF	4822 122 30027
C 0122	-20+50% 10NF	4822 122 31414
C 0123	-20+50% 10NF	4822 122 31414
C 0124	10% 1NF	4822 122 30027
C 0125	-20+50% 10NF	4822 122 31414
C 0126	63V 10% 100NF	5322 121 43083
C 0127	63V 10% 100NF	5322 121 43083
C 0128	63V 10% 100NF	5322 121 43083
C 0129	63V 10% 100NF	5322 121 43083
C 0130	-20+50% 10NF	4822 122 31414
C 0131	63V 10% 100NF	5322 121 43083
C 0132	-20+50% 10NF	4822 122 31414
C 0133	-20+50% 10NF	4822 122 31414
C 0134	-20+50% 10NF	4822 122 31414
C 0136	-20+50% 10NF	4822 122 31414
C 0137	-20+50% 10NF	4822 122 31414
C 0138	10% 1.5NF	4822 122 31169
C 0139	63V 10% 100NF	5322 121 43083
C 0140	-20+50% 10NF	4822 122 31414
C 0143	-20+50% 10NF	4822 122 31414
C 0159	-20+50% 10NF	4822 122 31414
C 0160	-20+50% 10NF	4822 122 31414
C 0161	10% 1NF	4822 122 30027
C 0162	-20+50% 10NF	4822 122 31414
C 0163	-20+50% 10NF	4822 122 31414
C 0164	10% 1NF	4822 122 30027
C 0165	-20+50% 10NF	4822 122 31414
C 0166	63V 10% 100NF	5322 121 43083
C 0167	63V 10% 100NF	5322 121 43083
C 0168	63V 10% 100NF	5322 121 43083

POSNR	DESCRIPTION	ORDERING CODE
C 0169	63V 10% 100NF	5322 121 43083
C 0170	-20+50% 10NF	4822 122 31414
C 0171	63V 10% 100NF	5322 121 43083
C 0172	-20+50% 10NF	4822 122 31414
C 0173	-20+50% 10NF	4822 122 31414
C 0174	-20+50% 10NF	4822 122 31414
C 0176	-20+50% 10NF	4822 122 31414
C 0177	-20+50% 10NF	4822 122 31414
C 0178	10% 1.5NF	4822 122 31169
C 0179	63V 10% 100NF	5322 121 43083
C 0180	-20+50% 10NF	4822 122 31414
C 0181	-10+50% 220UF	4822 124 20681
C 0182	-20+50% 10NF	4822 122 31414
C 0183	-20+50% 10NF	4822 122 31414
C 0184	-10+50% 47UF	4822 124 20699
C 0186	-20+50% 10NF	4822 122 31414
C 0187	-20+50% 10NF	4822 122 31414
C 0188	-10+50% 220UF	4822 124 20681
C 0189	-20+50% 10NF	4822 122 31414
C 0190	-20+50% 10NF	4822 122 31414
C 0191	-20+50% 10NF	4822 122 31414
C 0192	-20+50% 10NF	4822 122 31414
C 0193	-20+50% 10NF	4822 122 31414
C 0194	-20+50% 10NF	4822 122 31414
C 0195	-20+50% 10NF	4822 122 31414
C 0196	-20+50% 10NF	4822 122 31414
C 0197	-20+50% 10NF	4822 122 31414
C 0198	-20+50% 10NF	4822 122 31414
C 0199	-20+50% 10NF	4822 122 31414

Resistors

R 0101	MRS25 1% 2K61	5322 116 53327
R 0102	MRS25 1% 82E5	5322 116 53538
R 0103	MRS25 1% 619E	5322 116 53337
R 0104	MRS25 1% 2K37	5322 116 53536
R 0106	MRS25 1% 2K87	5322 116 53513
R 0108	MRS25 1% 19K6	5322 116 53258
R 0109	MRS25 1% 100E	5322 116 53126
R 0111	MRS25 1% 2K61	5322 116 53327
R 0112	MRS25 1% 82E5	5322 116 53538
R 0113	MRS25 1% 619E	5322 116 53337
R 0114	MRS25 1% 2K37	5322 116 53536
R 0116	MRS25 1% 2K87	5322 116 53513
R 0118	MRS25 1% 19K6	5322 116 53258
R 0119	MRS25 1% 100E	5322 116 53126
R 0126	0,3W 25% 10K	4822 105 10455
R 0128	MRS25 1% 4K64	5322 116 53212
R 0129	MRS25 1% 4K64	5322 116 53212
R 0131	MRS25 1% 2K61	5322 116 53327
R 0132	MRS25 1% 82E5	5322 116 53538
R 0133	MRS25 1% 619E	5322 116 53337
R 0134	MRS25 1% 2K37	5322 116 53536
R 0136	MRS25 1% 2K87	5322 116 53513
R 0138	MRS25 1% 19K6	5322 116 53258
R 0139	MRS25 1% 100E	5322 116 53126
R 0182	MRS25 1% 5E11	4822 116 52999
R 0183	MRS25 1% 5E11	4822 116 52999
R 0184	MRS25 1% 5E11	4822 116 52999
R 0186	MRS25 1% 10E	4822 116 52891
R 0191	MRS25 1% 46K4	5322 116 53314
R 0192	MRS25 1% 3K16	4822 116 53021
R 0193	MRS25 1% 3K16	4822 116 53021

Semi-conductors

POSNR	DESCRIPTION		ORDERING CODE
V 0191	BC548C	PEL	4822 130 44196
V 0192	BZX79-C5V1	PEL	4822 130 34233

Integrated circuits

D 0101	PC74HCT259P	PEL	5322 209 11115
D 0102	PC74HCT259P	PEL	5322 209 11115
D 0104	HEF4104BP	PEL	4822 209 10273
D 0106	HEF4104BP	PEL	4822 209 10273
D 0112	HEF4053BP	PEL	5322 209 10576
D 0113	HEF4053BP	PEL	5322 209 10576
D 0114	HEF4053BP	PEL	5322 209 10576
D 0116	P8291A	INT	5322 209 81264
D 0117	MC3448AP	MOT	5322 209 11317
D 0118	MC3448AP	MOT	5322 209 11317
D 0119	MC3448AP	MOT	5322 209 11317
D 0121	MC3448AP	MOT	5322 209 11317
D 0122	PC74HCT02P	PEL	5322 209 11106
N 0101	LM324N	N.S	4822 209 80587
N 0102	TDA1540P	PEL	4822 209 81453
N 0103	TDA1540P	PEL	4822 209 81453
N 0106	TDA1540P	PEL	4822 209 81453

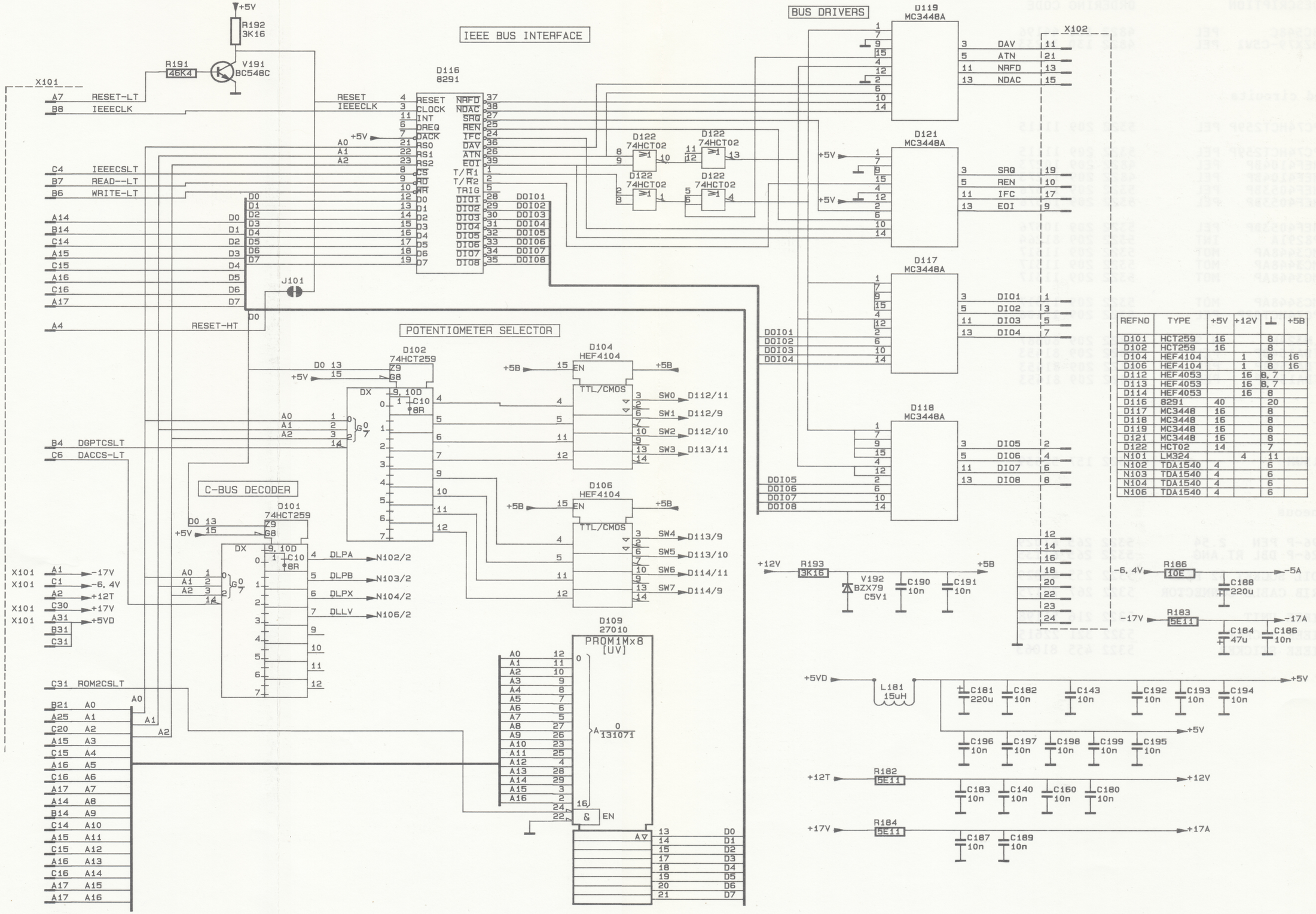
Coils

L 0181	15UH		5322 157 52539

Miscellaneous

X 0101	96-P PEN 2.54		5322 265 61029
X 0102	26-P DBL RT.ANG		5322 265 61135
	DIL SOCKET 32 PENS		5322 255 40829
	RIB CABLE CONNECTOR		5322 267 70175
	IEEE UNIT		5322 216 51198
	IEEE SOCKET		5322 321 22615
	IEEE STICKER		5322 455 81063

11. CIRCUIT DIAGRAMS AND P.C.B. LAY-OUTS



REFNO	TYPE	+5V	+12V	⊥	+5B
D101	HCT259	16		8	
D102	HCT259	16		8	
D104	HEF4104		1	8	16
D106	HEF4104		1	8	16
D112	HEF4053		16	8, 7	
D113	HEF4053		16	8, 7	
D114	HEF4053		16	8	
D116	8291	40		20	
D117	MC3448	16		8	
D118	MC3448	16		8	
D119	MC3448	16		8	
D121	MC3448	16		8	
D122	HCT02	14		7	
N101	LM324		4	11	
N102	TDA1540	4		6	
N103	TDA1540	4		6	
N104	TDA1540	4		6	
N106	TDA1540	4		6	

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Figure 11.1 Circuit diagram of IEEE unit, IEEE bus interface

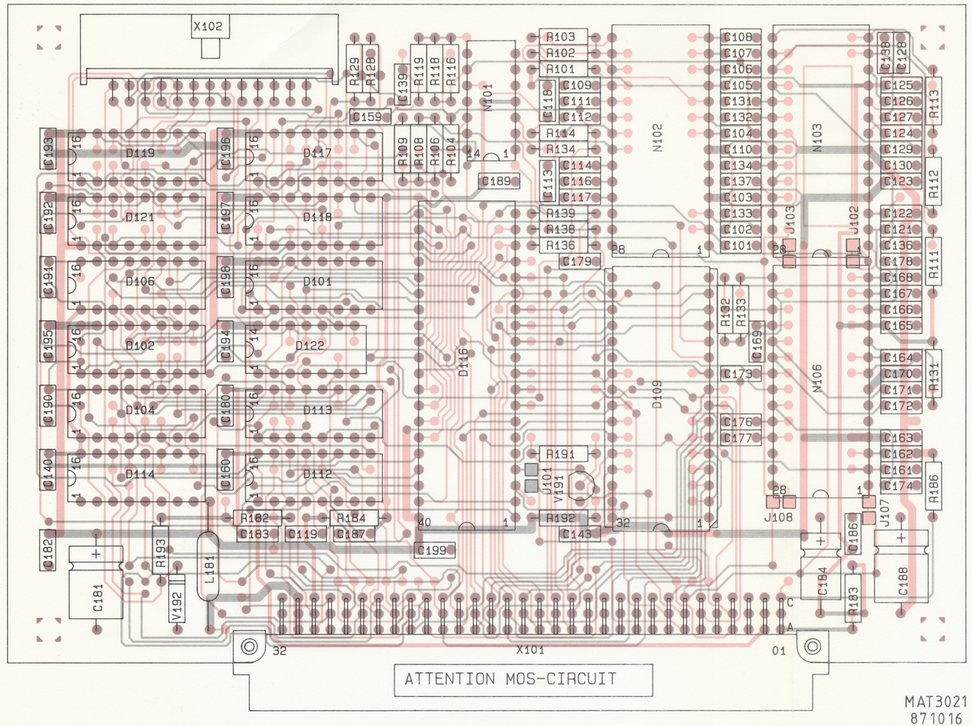

Figure 11.2 IEEE unit p.c.b.

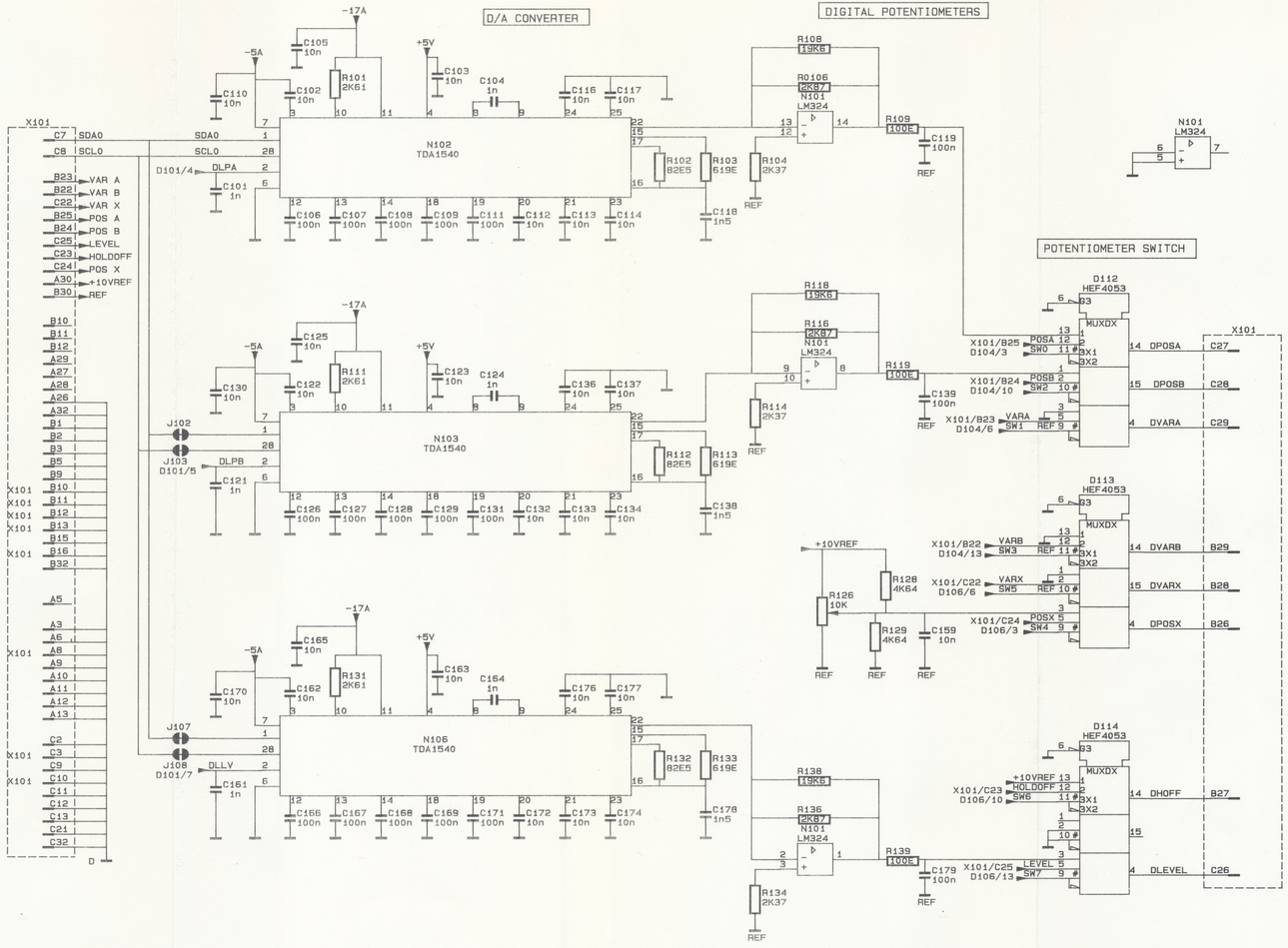

Figure 11.3 Circuit diagram of IEEE unit, digital potentiometers